Rethinking Social Acceptance of Renewable Energy

Understanding Solar Energy
as a Common Pool Resource
through DIY Workshop

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Master's Thesis for Master of Art and Design
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Goeun Park

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List of Abbreviations

CPR	Common Pool Resource
DIY	Do-It-Yourself
HCI	Human Computer Interaction (HCI)
LL	Liter of Light
LS	Little Sun
PT	Practice Theory
PV	Photovoltaic
STS	Science Technology Study
SV	Sungdaegol Village
SDW	Solar DIY Workshop
SYKE	Suomen ympäristökeskus (Finnish Environment Institute)
TM	Transition Management
TTT	Transition Town Totnes

Abstract

The importance of renewable energy development at the local level has been increasingly emphasized due to a rapid increase of human-driven CO2. However, public resistance to renewable energy resources has frequently evident in many places. This thesis defines that the current renewable energy regime is largely driven by governmental assistance and energy markets. The relationship between people and energy in this regime seems to be deliberate, separated and one-way. In order to reshape the human-energy relations towards more interactive, democratic and diverse options, this thesis proposes a Solar DIY Workshop, intended to enlighten participant's understanding that renewable energy can be a collective and grassroots initiative through participation in a self-building activity. Overall, six Solar DIY workshops were held in different locations across Finland. Through action research and semi-structured interviews, this study concludes that understanding renewable energy as a common pool resource is achievable by participation in a workshop based self-building activity. Having a DIY activity with solar PVs can create a positive influence on participants' attitude toward the technologies and increases the willingness of involvement in self-sufficient renewable energy production.

Specifically, the DIY effectively empowers participants to play different roles, for example as energy producers, makers and organisers of the DIY workshop instead of act as mere customers. In addition, it was successful to increase interactions among participants and willingness to be part of community-led renewable energy initiatives. However, this study still finds some hesitation in participants' attitude to engage in community-led renewable energy initiatives. In order to increase social acceptance of renewable energy at community level, further research should focus on how to increase the familiarity of community-led renewable energy.

Keywords: Social acceptance, Renewable energy, Community-led renewable energy, Common pool resource, DIY activity, User empowerment

01.

Introdction

1.1 Background

In recent years, there has been a surge of interest in renewable energy due to catastrophic climate change caused by anthropogenic carbon dioxide emission. An increase in carbon emissions caused by human activity backfires on human society as a serious threat. The number of extreme weather events, ocean acidification and sea-level risings are conspicuous phenomena. Human influence is the most apparent factor in energy sector. Almost every human activity is considerably co-dependent on use of energy from heating, transformation, manufacturing and agriculture (Vandenbergh et al. 2010). According to a paper published by Intergovernmental Panel on Climate Change (2014), energy supply is responsible for 47 percent of global CO2 emission. More notably, the energy-related carbon dioxide emissions caused by human activities, are expected to increase continuously.

For this reason, there is a pressing need energy transition, based on fossil resources such as natural gas, oil and coal, to a more sustainable energy system based on clean energies such as solar, wind and geothermal power. There is no doubt that the increase in renewable energy use – along with improving energy efficiency - can play an important role in facilitation the transition to a future of sustainable energy. Acknowledging the significance of the renewable energy transition, many governments are aggressively working to extend domestic deployment of the renewable energy by introducing diverse energy policies. Over two thousand central and regional governments in the world have established renewable energy objectives in 2018. Some of these have set up the ambitious goal of a 100 percent renewable energy supply by 2040. Such governments include: Frankfurt, Germany; San Francisco, CA (local government); California, USA (state government); and Fukushima, Japan (Non-State Actor Zone for Climate Action, NAZCA 2018). The Finnish government also has established a national target of increasing energy shares in renewable sources to 50 percent in final energy consumption by 2030 and by introducing diverse national energy strategies to attain this goal (Huttunen 2017).

Despite intensified national efforts to increase the deployment of renewable energy, the actual implementation of this objective is slow. The Finnish Innovation Fund Sitra (Rocha et al. 2016) recently published report suggested that the Finnish government needs to consider multi-level actions in response to current measures taken by the government that are considered to be insufficient for meeting the target. The existing concern allowed room for particular attention to renewable energy developments at grassroots level as an additional action plan for the government to effectively increase diffusion of the renewable energy.

The renewable energy development at grassroots level can take on diverse forms of action: installing rooftop Photovoltaics (PV); running collective renewable energy farms with neighbours. The importance of self-sufficient renewable energy production carried out by individuals and communities is being highlighted and recognized in scientific literature. The vast range of researches of grassroots

actions regarding renewable energy include: Sustainable Energy Utility (Byrne et al. 2009), Community Renewable Energy (Walker and Devine-Wright 2008), Small-Scale Renewable Energy (Nair and Garimella 2010), Citizen-led Renewable Energy (Byrne et al. 2007; Aukeala 2017) and Microgrid Energy (Venkataramanan and Marnay 2008).

Unfortunately, this approach frequently faces public disinterest or even social rejection (Devine-Wright 2005; 2009; Devine-Wright et al. 2017; Sovacool 2009; Clausen 2016; Wolsink 2012a; Wüstenhagen 2007). Even though there is a general understanding in society that renewable energy is good and beneficial, the public interest in participating in renewable energy transition is low. Worse, they refuses to invite renewable energy technologies into their own backyards. Finland is not an exception to such controversial phenomena. Public response to the renewable energy appeared positive in various surveys (European Commission 2007; E. Moula et al. 2013). However, the actual public interest towards citizen-led renewables was relatively low (Aukeala 2017). The inconsistency in public attitude recently caught the attention of Finnish researchers. Social acceptance of renewable energy is one of the most increasingly discussed and studied subjects in renewable energy research field in Finland today. Those studies, in many cases, only provide general description of public resistance of renewable, and heavily incline towards energy provider and expert perspectives in defining obstacles of the renewable energy deployment at local levels (Ruggiero et al. 2015; Aukeala 2017). Public voices – users, customers and citizens- were heard mostly through questionnaires or surveys (E. Moula et al. 2013; Jung et al. 2016), which are not necessarily accurate reflections of actual respondent practice.

However, recent discourse on the social acceptance of renewable energy goes beyond the dichotomy between acceptance and rejection toward comprehensive understanding of the complexity and dynamics of the phenomenon. (Ryghaug et al. 2018; Chilvers and Longhurst 2016) Public engagement is perceived to be based merely on personal preference and dealt with only once while the decision-making is in process. Public engagement, in the new argument, is a consequence of more dynamic interactions among actors (Chilvers and Longhusrt 2016).

This thesis will focus on the dynamics of social acceptance. The social acceptance of renewable energy can be seen as a consequence based on the configuration among people, technologies and ways of participation. In this respect – in a conventional human-energy relationship – people primarily act as recipients of new energy technology (e.g., mere customers and passive end-users); energy is mainly consumed as commodity. As a result, the relationship between human and energy seems to be distant, deliberated and one-way; public participation is also limited. Thus, there is an increasing voice that the conventional, human-energy relationship should be reconsidered. Alternative relationships between people and the technologies within the relationship can also be created.

In order to fill these voids, this thesis proposes a Solar DIY Workshop as a new way of public engagement in renewable energy transition.

The primary objective of the workshop is to open accessibility to the renewable energy as a common pool resource by providing participants a self-building activity with renewable energy. The argument for renewable energy as a common pool resource is still a minor one in the academic world, but it is gaining growing attention in the renewable energy research field (Byrne et al. 2009; Wolsink 2012a; 2013; Roelich and Christof 2015). While the human-energy relationship is limited in a conventional energy regime, governing the renewable energy as a common pool resource encourages people to be governed in a collective manner and engage in an active, creative and interactive relationship with the technologies. Providing a self-building activity with people who share a same interest also can be a novel way to foster the interactive relationship by encouraging practitioners to recognize renewable energy toward the common benefit. The results of the Solar DIY workshop are expected to contribute in creating favorable insights towards public acceptance of renewable energy, thereby suggesting new human-energy relations and an alternative way of engagement in renewable energy transition.

1.2 Research Question

An ultimate aim of this thesis is to explore how human-energy relationships, particularly with renewable energy, can be changed through participation in a self-building activity and how this participation can shift of understanding on renewable energy as a commons pool resource, encouraging and fostering public engagement in renewable energy transition. Among renewable energy technologies, solar energy has been chosen for this case study because of high accessibility of this technology. In addition, since this thesis focuses on a socio-technical aspect of renewable energy, technical and financial issues are excluded.

Therefore, the following research questions are suggested and theoretically and practically explored.

Q. How can Solar DIY workshop contribute to the workshop participants' perceptual change on solar energy from commodity to common pool resource?

q-1. How does Solar DIY workshop influence participants' understanding of solar energy?

q-2. How does Solar DIY Workshop encourage the participants to be more personally involved in self-sufficient energy production?

q-3. How does Solar DIY workshop impact people's perspective on community level activities regarding renewable energy?

q-4. What alternative support mechanism is possible for solar energy distribution?

1.3 Thesis Outline

This thesis consists of seven chapters. Chapter 1 lays out the main topic and focus of the thesis. Background information will be provided by summarising current issues and challenges of renewable energy distribution at grassroots levels. The research gap on the social acceptance toward renewable energy will also be examined. Chapter 2 reviews the diverse bodies of theory associated with renewable energy such as different perspectives on public engagement, CPRs and DIY ethos. The review will establish a strong foundation for my argument suggesting renewable energy as a CPR through a DIY activity is an adequate alternative to current energy regime discourse with a range of examples and comparative analysis. The following chapter outlines methodology. This section explains why the applied method of inquiry is appropriate to study the impact of DIY activity in practitioner's understanding on renewable energy. Chapter 4 describes the process of designing and implementing of Solar DIY Workshop as a way of participating in renewable energy transition. Many considerations were addressed in the process of planning the Solar DIY Workshop. Six Solar DIY Workshops, held across Finland, will also be explained in detail. Participant's responses will be evaluated in Chapter 5. Thirteen semi-structured interviews with fifteen participants were delivered to measure the effect of DIY workshops on participant perception. Chapter 6 presents further discussion related to the research topic, and finally, Chapter 7 concludes the research findings.

02.

Theoretical Discussion

This chapter provides an overview of literature related to the research topic: social acceptance of renewable energy. Since the renewable energy deployment on local regions has frequently faced public conflicts, it is significant to look into the reasons why such social resistance has emerged; and what alternative approach is necessary to increase the public participation in the renewable energy transition. In order to comprehensively understand the concept of social acceptance in the realm of renewable energy, it is important to explore diverse theoretical perspectives and newly arising arguments associated with the issue. One of new arguments gaining attention is that renewable energy should be identified as a common pool resource (hereafter CPR). This view highlights the collective action in governing renewable energy which has been largely neglected but has seen increased interest recently in studies related to renewable energy. However, without questioning of "how to put the argument into action," this new argument would be less compelling because of the absence of support mechanisms in renewable energy distribution. Therefore, this thesis embarks upon exploring diverse theoretical perspectives of the social acceptance and highlights the notion of CPRs and DIY activity to shape a new way of public participation in renewable energy transition.

2.1 Renewable Energy and Social Acceptance

2.1.1 Renewable Energy Diffusion

Renewable energy distribution has received a particular attention as one of the prominent proposals for renewable energy transition. However, the tide of change implies not only a mere replacement of energy resources with sustainable ones which emits less carbon dioxide, but also requires extensive changes in social, institutional and cultural aspects of energy system (Miller et al. 2013). Thus, the energy system is now undergoing significant reorientation from a system based on large-scale, centralized and top-down organization to a more diverse energy system which is decentralized, small-scale and bottom-up. The importance of renewable energy transition is a topic that is also being explored increasingly in the academic world. Research focusing on the significance of the transition range significantly: Sustainable Energy utility (Byrne et al. 2009), Community Renewable Energy (Walker and Devine-Wright 2008), Small-Scale Renewable Energy (Nair and Garimella 2010), Citizen-led Renewable Energy (Byrne et al. 2007; Aukeala 2017) and Microgrid (Venkataramanan and Marnay 2008).

Through these studies, it is increasingly acknowledged that small-scale, renewable energy led by individuals and communities can make a great contribution to achieving the decarbonisation of the energy system (Seyfang et al. 2013; Becker and Kunze 2014; Schoor and Scholtens 2015). It can also bring many economic and social benefits: alleviating fuel poverty; increasing job opportunities; growing local economy; and increasing community resilience (Seyfang et al. 2013; Walker and Devine-Wright 2008; Roelich and Knoeri 2015). Understanding the benefits, many governments have aggressively promoted the small-scale, renewable energy initiatives by focusing on local activities. By way of example, the community renewable energy has become an emerging theme in UK energy policies over the past decade (Walker et al. 2010). Germany also has showcased numerous, successful, community-owned, renewable energy initiatives through diverse energy policies (Julian 2014). According to Aukeala (2017), although citizen-led, renewable energy initiatives are rarely seen in Finland, the transformative potential is increasingly recognized among Finnish energy experts.

2.1.2 Challenges and Social Acceptance

Despite intensive efforts at a national level, actual implementation of renewable energy at individual and community levels is slow and unclear. Technical defects and a lack of a competitive market narrative have heavily dominated renewable energy development debates (Lawhon and Murphy 2011; Geels and schot 2007). In recent years, a socio-technical aspect of renewable energy deployment has been seen as a major threat to successful development of renewable energy (Sten 2014; Sovacool 2014; Geraint and Gianluca 2016), terminating in local conflict.

Although the governments are putting much effort into promoting and supporting citizen-led renewable energy, public oppositions have frequently occurred in the beginning of the diffusion curve of renewable energy. Significantly, the public attitude is ambivalent. People report positive responses towards renewable energy in surveys but in reality, these endorsement easily devolve into hesitation. According to EU survey on public attitudes towards energy technologies in Europe (European Commission 2007), 71 percent of respondents supported the use of wind energy whereas only 3 percent were opposed. However, many case studies revealed public disinterest, opposition or even strong protest against installation of renewable energy facilities in their own backyards for various reasons: impacts on landscape, biodiversity loss, health and noise problems and reduction in property values (Wolsink 2007; Sovacool 2009; Ogilvie and Rootes 2015; Jung et al. 2016; Geraint and Gianluca 2016; Clausen 2017).

In the recent decade, this controversy in public attitude towards renewable energy has been theoretically conceptualized with the notion of social acceptance and has drawn a growing academic interest (W stenhagen et al. 2007; Devine-Wright et al. 2017; Geraint and Gianluca 2016). Social acceptance has been increasingly highlighted through not only studies on energy technology, but also through a variety of social science research studies: Grassroots innovation; Practice theory; Social movement theory; Transition theory (Chilvers and Longhurst 2016; Geraint and Gianluca 2016). Notably, these studies all claim that understanding local response to the renewable energy has considerably become relevant to success of renewable energy implementation at local level. (Wüstenhagen et al. 2007; Wolsink 2012a; Chilvers and Longhurst 2016; Devine-Wright et al. 2017). Unlike the mainstream energy system, where energy farms are situated far from resident areas, the small-scale renewable energy production has to be installed in close proximity to the residential areas in order to increase security of the energy supply. Yet, as illustrated earlier, close proximity to power plants seems to trigger people to act against its implementation, therefore, the causing the spread of renewable energy and the realization of renewable energy goals to be interrupted.

Having acknowledged its importance, numerous efforts have been made to reveal why the public resistance to the renewable energy is arising and how it can be mitigated. The infancy of these studies can be summarized by one word, "NIMBYism" (Not In My Back Yard), which blames irresponsibility, selfishness and ignorance on citizens (Barnett et al. 2012; Walker et al. 2010). Recently, however, such view is largely criticized for several reasons. Great numbers of scholars argue that it greatly underestimates the complexity of the phenomenon of public engagements (Aitken 2010; Devine-Wright 2009; Haggett 2011; Wolsink 2012b; Ryghaug et al. 2018). Instead, Karlstrøm and Ryghaug (2014) suggested that one reason for public resistance is due to people's political preferences that shape their responses. Others emphasised the place attachment that people have on selected venues (Devine-Wright 2009; 2011; Wolsink 2011). Haggett (2008), Hall et al. (2013) and Wolsink (2007) argued the public resistance could be more associated with a deficit in the process and ways of participating rather than the level of knowledge about renewable energy.

2.1.3. Dynamics of Social Acceptance

A rising new argument on the social acceptance of renewable energy asserts that the discussion needs to go beyond the dichotomy between acceptance and decline, towards a more comprehensive understanding of dynamics of social acceptance. Predominantly, social acceptance has been merely perceived as something determined by "particular assemblage of technologies and related infrastructures" (Geraint and Gianluca 2016), "personal preferences" (Bertsch et al. 2016), fixed "state" (Whitmarsh et al. 2011) or at a one-off event (Chilvers and Kearnes 2016). Decoupling between the new energy technologies and public acceptance, however, has more to do with limited perspectives on the public engagement. Geraint and Gianluca (2016) suggest that the narrowed views rather provoke public resistance to the renewable energy.

> *This (social acceptance) has largely been viewed in terms of individual projects and therefore primarily a responsibility of those developing individual projects. This has led to the promotion of different types of isolated 'fixes' such as community benefits or more consultation, which has been unable to increase the overall level of social acceptance. (Geraint and Gianluca 2016, 2)*

In recent years, there is a growing argument that the social acceptance is a consequence of dynamic interactions between involved actors (Chilvedrs and Longhurst 2016; Ryghaug et al. 2018; Clausen 2016; Geraint and Gianluca 2016). In their recent paper, Chilvers and Longhurst (2016) introduce a socio-material framework which conceptualizes a configuration of public participation based on three dimensions – subject, object and model of participation as illustrated in left image of figure 1. In this theory, public engagement is defined as a flexible phenomenon to change based on who is engaged, which object they are engaged with, and which way they are engaged. The changeability of the public attitude to the renewable energy is supported by much empirical research (Devine-Wright 2005; Wolsink 2007). For example, Wolsink (2007) found that the level of community acceptance decreases in a proposal stage mainly because of fear and unfamiliarity with renewable energy. Yet, acceptance can be subsequently increased after the experience with the renewable energy has eliminated the unfamiliarity. Therefore, the social acceptance does not exist in a fixed state but in a continuously changing domain based on the configuration and interactions among people, technologies and means of participation.

The argument emphasizing the dynamics of social acceptance (see left picture of figure 1) is different from the predominant view on social acceptance (see right picture of figure 1) in the following respects. First, while the latter view puts more weight on external actors - government supports and market force in sharing the social acceptance (Wüstenhagen et al. 2007; Wolsink 2013, 11), the new approach focuses on internal diversity and interconnectivity of the public participation itself. Second, the latter studies tend to look at one subject, one object, one specific procedural format or one political philosophy of the participation at a time, in isolation (Chilvers and Longhusrt 2016). However, the new perspective encompasses all actors involved and acknowledges inter-connectedness in the construction of the overall phenomenon.

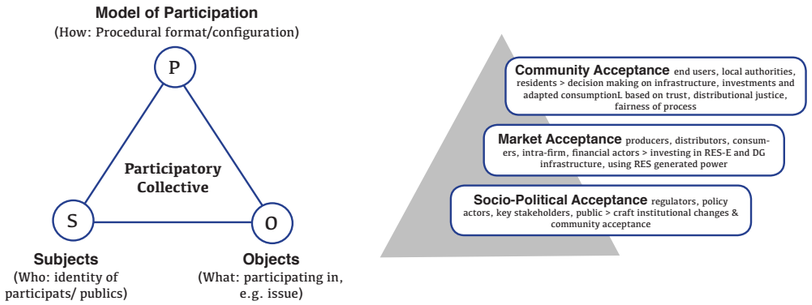


Figure 1 A comparison of conceptualizations of social acceptance. Left image: A socio-material collective of participation (Chilvers and Longhurst 2016, 590) Right image: three dimensions of social acceptance of renewable energy innovation (Wüstenhagen et al. 2007; Wolsink 2013, 11)

Furthermore, it is essential to consider the complex and dynamic nature of social acceptance because it draws attention to an underlying fact that deployment of renewable energy is accompanied by a socio-technical change. While a technical development has been placed in the centre of the renewable discourse, understanding the dynamics of social acceptance extends the discourse towards the socio-technical issue (Sten 2014; Sovacool 2014). This leads to the following questions: How such new energy systems are socially constructed and embedded in? (Wolsink 2012a, 824); and what influence does the renewable energy have on human perception, behaviours and attitudes to those technologies (Ryghaug 2018; Latour 2005). Human-derived influence that shapes technologies has been a much studied subject in energy literature for example, how people perceive renewable energy technologies and respond to them, a contribution by the technologies in shaping people's behaviors and attitude has been largely neglected. However, the new argument highlights that an influence yielded by the technologies is just as important as those of human influence in constructing public response to the technologies. This is because the human-energy relation is fundamentally inter-dependent (Sten 2014; Sovacool 2009; Geraint and Gianluca 2016). Therefore, the interactive communication between people and the alternative technologies should be considered as one of the most significant factors in considering the social acceptance of renewable energy.

2.2 Renewable energy as a Common Pool Resource

2.1.1 Commodification of Renewable Energy

In order to understand the social acceptance of renewable energy, it is then necessary to explore first what relationship has been established between individuals and renewable energy in their current energy regime setting. Generally, the mainstream energy system is fossil-fuel based, centralized by states and partially privatized as illustrated in Figure 2. Delivering energy from energy generators via a national grid is the typical way for households to receive energy in most industrialized countries. In this regime, it is assumed that governments and energy corporations are main energy providers who are in charge of securing electricity supply. All decisions from energy generation to supply are made centrally. The role of ordinary citizens is largely limited to consuming the energy and paying energy suppliers for use of the energy.

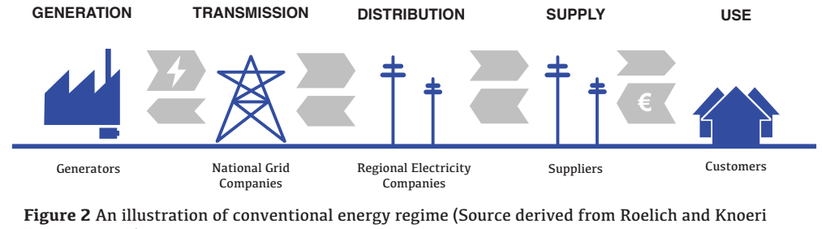


Figure 2 An illustration of conventional energy regime (Source derived from Roelich and Knoeri 2015, 7 and 9)

It seems evident that the predominant energy system, which is largely based on nationalization and privatization, has also been applicable to the development of renewable energy (Hu 2018; Batel and Devine-Wright 2015). The number of projects for construction of renewable energy technologies at national levels has substantially increased during the past decade. For example, the Australian government has reported an increase of large-scale, renewable energy powerstation capacity and generation by 64 percent in 2016 compared to previous year (Cleanenergyregulator). Finland is known for the second-highest share of renewables in Europe (Eurostat 2019). However, its renewable energy production is dominated by a small group of energy providers. Individual participation of households as small-scale renewable energy producers - for example owning rooftop PVs and windmills - is rarely seen. The centralized renewable energy development is rapidly developed through a political-business alliance. Several studies indicate that the direct and indirect government supports are becoming key incentives to boost the global renewable energy market (Byrne et al. 2009; Wolsink 2012; REN21 2017). Many governments are aggressively working to extend domestic deployment of renewable energy, however, their energy policies are largely dominated by economic instruments (Roelich and Knoeri 2015). The regulatory and pricing policies such as feed-in tariffs (FiTs), public finance and fiscal incentives to renewable industry through public-private partnership (PPPs) are the most obvious examples.

The centralization of the renewable energy development is supported by the very influential theory, "The Tragedy of the Commons." An American ecologist, Garrett Hardin (1968), published the article of the same title which has provided a profound metaphor in contemporary resource management literature. The main argument of the theory is that centralization and privatization are the most effective ways to manage the common resources without causing excessive exploitation (Hardin 1968). His claim is that a human is a rational being that inevitably makes choices based on maximizing benefits that can easily cause an overuse of common resources. Because of the self-interest of human being, he argues that management of the scarce, shared resources requires strong control by states and markets.

Perhaps it is not surprising that state-led and market-driven renewable energy development produces conspicuous results. One result is the acceleration of commodification of the renewable energy (Devine-Wright 2007; 2012a; Byrne et al. 2009; Wolsink 2012; Roelich and Knoeri 2015). In fact, the energy as a commodity is already a predominate perception in many countries and it has not been replaced for the last two decades (Devine-Wright 2007; Roelich and Knoeri 2015). The energy in the market society is widely perceived as something interchangeable like money, labour or land.

However, the commodification of renewable energy is not beneficial in reducing carbon emissions because it is highly likely to prioritize capital values over cultural, social and environmental values of renewable energy (Devine-Wright 2012). In addition to this, it also causes a social dilemma – Enclosure (Ostrom 1990). Mainstream energy provision has ensured that only a few actors – central and regional governments, large energy corporate entities and few wealthy individuals - participate in the renewable energy markets. It renders the general public disconnected from energy sources and reduces their role to mere energy consumers and passive end-users. In mainstream energy provision, human relationship is eventually limited, separated and deliberated as solely acting as commodity and consumers (Pidgeon et al. 2014).

According to Karl Polanyi ([1944] 2001), this phenomenon is understood as *dis-embedding* from social relations. He argues that economy is embedded in social relations and there are no pure economic activities disassociated with society. However, in society where market economy largely dominates, the economic activities become dis-embedded from social relations and develop with its own logics and models. Then, the social and interhuman aspects become separated and replaced and communities are inevitably broken up (Polanyi [1944] 2001).

In light of the dis-embedded process of renewable energy from society, there is a growing argument that the conventional regime of renewable energy should be replaced by a new forms of institution (Künneke 2009; Goldthau 2014; Roelich et al. 2015). The separated social relations caused by commodification of renewable energy needs to be re-embedded into society and a new way of governing should be involved in this process (Polany [1944] 2001; Clausen 2016). Furthermore, in the new way of governing, all actors involved should play different roles other than those of commodity owners or consumers (Wolsink 2012a). Taking this into consideration, relocating the renewable energy as the CPR has received growing attention (Künneke 2009; Goldthau 2014; Roelich and Christof 2015).

2.1.2 Renewable Energy as a Common Pool Resource

CPRs refers to "a natural or man-made resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use (Ostrom 1990, 13)." This is not a new idea but a long-standing way of managing common resources, which have existed in diverse forms for centuries. Common pools resource includes not only resources, systems and norms but also activities based on the ideal of CPRs, recently defined as "communing" (Bollier 2007). For example, considering energy as a CPR implies the governing the energy resources, supply infrastructures, associated social norms and activities in a collective manner.

Over the last decade, the concept of CPRs has attracted greater interest in the diverse range of social sciences (Laerhoven and Ostrom 2007). The regained attention is primarily motivated by several factors. First, there is an increase of environmental degradations over natural resources despite enormous efforts. Recently, the strong control by states or energy markets gradually becomes less appealing in addressing the environmental and social problems such as global warming and preservation of national resources (see more details about state failures: Roelich et al. 2015; State and market failures: Ostrom and Walker 1997). Instead, continued diminishing of the environment resources by over-use requires a second look at the conventional management institutions over the CPRs to find a new forms of governing. In addition, social changes bring the emergence of 'man-made common pools resources' and the need to discuss how to perceive and manage the resources. Previously, the focus of literature on CPR has been on natural resource management in areas like fishery, forestry, irrigation, water management and animal husbandry. However, with human-constructed resources increasingly emerging, literature on governing CPRs are also diversified to include various subjects for instance public spaces (Barnes 2006), knowledge (Desouza 2008; Basu et al. 2017) and information (Beagle 1999).

In this regard, there is a growing view that renewable energy can be seen as new CPR (Byrne et al. 2009; Wolsink 2012a; 2013; Roelich and Knoeri 2015; Künneke 2009; Goldthau 2014). There are several supporting factors to define renewable energy as a CPR. First, features of renewable energy satisfies prerequisites of commons goods, which exhibit non-excludable and rivalrous consumption (Wolsinki 2012a). Second, the importance of renewable energy is considerably increasing as an essential part of maintaining a healthy living condition (Ostrom 1990; Shiva 2018; Linebaugh 2014). In 2015, United Nations published The Sustainable Development Goals Reports 2016 and its seventh goal is to "ensure access to affordable, reliable, sustainable and modern energy" (United Nations 2016). In our society, which is significantly threatened by the increased carbon dioxide emission, renewable energy is not an option but is imperative to secure reasonable quality of life in the long term.

More evidently, this argument highlights the fact that the renewable energy is a collective matter which should be accessible for all and needs to be owned and managed by members of communities. Especially in the conventional renewable energy regime that is dominated by centralization and privatization, collective action in managing the

renewable energy has been largely neglected. However, approaching renewable energy as a CPR sheds light on power of people in minimizing the negative effects of human-derived carbon dioxide.

Elinor Ostrom (1990) has proved, through a range of laboratory and field studies across the world, that CPRs can be sustainably and equitably held at local levels without shortcomings of this resource. Their case studies show that self-governance at the local level can be even far more effective to govern scare resources than privatization and centralization, generating more desirable social benefits as Ostrom stated below (1990):

> *All efforts to organize collective action, whether by an external ruler, an entrepreneur, or a set of principals who wish to gain collective benefits, must address a common set of problems. These have to do with coping with free riding, solving commitment problems, arranging for the supply of new institutions, and monitoring individual compliance with sets of rules. (Ostrom 1990, 27)*

The role of individuals in governing renewable energy is essential. For successful governing renewable energy as a CPR, the role of the individuals needs to be expanded beyond mere customer and end-user towards that of an active and inventive actor, and such transformation can be achieved through active public participation (Wolsink 2012a). For example, in a commonly owned renewable energy system, people involved in all steps of decision-making carry out multiple roles, e.g., energy producers, managers, supplier and distributors. In some cases, they even suggest advanced technical solutions rather than professional technicians (Hyysalo et al. 2013). The importance of the expanded role of users and its contribution to social change are also highlighted in diverse theories such as front-runners in transition management (TM), niche actors in strategic niche management and practitioners in PT.

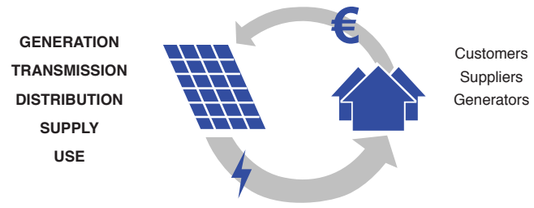


Figure 3 A presentation of collective governance of renewable energy

Presumably, there still remains doubt concerning the collective power in terms of preventing large scale problems such as an increase CO2 emission. Also, existing ways of public participation in renewable energy transition has been considerably limited. In deployment of the renewable energy in the conventional way, options for the public to engage in the energy transition are few such as structured workshops or official activities led by external consultants - like regional governments and Consumer research led by university (Ryghaug et al. 2018)- are limited. These are often described as formal, deliberated (Clausen 2016) and staged (Ryghaug et al 2018). Paulos and Pierce (2011, 3) also argue that in this regime, users have a limited participation, acting on a 'plug-and-forget' basis.

However, there are examples of successful outcomes of community participation in governing renewable energy. The first and foremost example is *Transition Town Totnes* (TTT) in England. TTT is one of the leading, community-led transition towns which was initiated by Rob Hopkins and Naresh Giangrande in 2006. Their main focus is to encourage behaviour changes in order to save energy, thereby mitigating man-made carbon dioxide. They found the solution from collective action. Most programs at TTT, including installing Solar PV panels, are run based on a small-sized community called Transition Together (T-tog). In T-tog, a small community is formed around 5-6 households and does self-study on energy issues. Together, they find ways to collaborate on activities for saving energy. In 2011, 56 groups or 468 households participated in T-tog and reduced 600 tons of CO2 emissions each year. The T-tog experience proved that local communities could considerably contribute in reversing global warming by managing the CPRs in collective manners (Ashdenawards 2011) (See more details from https://www.transitiontowntotnes.org).

The *Sungdaegol Village* (SV) case, in Seoul, South Korea, provides another interesting example. SV was first organised back in 2011 by a number of middle-aged women who belonged to the committee of local children's library in Sangdo-dong. After the Fukushima Daiichi nuclear disaster in 2011 in Japan, the women began to doubt about the modern energy system largely dependant on nuclear power. They implemented diverse, energy efficient strategies and encouraged the whole village to install renewable energy. As a result, SV is now well-known as the citizen-led and energy, self-sufficient village. What is significant about the SV example is that, unlike with the TTT, this village had confined spaces and limited funds to install new technologies. Fortunately, they found small size operations that fit and came up with a mortgage plan to reduce the initial investment cost. Remarkably, they made efforts to increase the accessibility of the renewable energy by running an energy store, Energy Supermarket. Residents of the area could buy small PV panels and energy efficient devices there. The village successfully achieved "energy, environmental, economic and social sustainabilities through improving energy self-sufficiency ratio by communities with awareness of energy problem (Lee 2016)." (see more details http://sdgpeople.or.kr)

Figure 4 Left image: Sungdaegol Village (http://sdgpeople.or.kr), Right image: T-tog group's meeting (https://www.transitionculture.org/2010/07/30/first-results-from-transition-together-evaluation/)

2.2.3 Key Conditions for Effective Common Pool Resources

The fore-mentioned cases have not spontaneously emerged. Tremendous effort was put into successful implementation of their objectives. Several studies point out that successful governing of CPRs takes place once the community reaches certain conditions. Byrne et al. (2009) broadly categorised the required conditions into collective responsibility and shared benefits, while Dietz and his colleagues (2003) suggested in detail the following five conditions: communities need to have an ability to monitor resources; they require appropriate rates of change; they rely on active interaction and dense social network; they demand a low cost unavailable to outsiders; and necessitate users' support of monitoring and rule enforcement (see details from Diet et al. 2003). These claims, in turn, can be summarized into two important conditions: having knowledge of renewable energy and building a trust among people involved. These claims illustrate the importance of social aspects in transforming the modern energy regime to that of CPRs:

Empowering Users by Providing Knowledge

The first condition is to empower people to act by providing knowledge of renewable energy. Dietz et al. (2003, 1908) defines that effective collective governance needs the ability to monitor the resources. For communities to acquire this ability, acquisition of basic understanding and knowledge related to new energy technologies has to precede it. People need to comprehend scientific information such as how to produce the energy sources and how to estimate energy supply and demand.

Such scientific knowledge has to be complemented by empirical knowledge because of the intermittent nature of renewable energy (Pidgeon et al. 2014; Roelich and Knoeli 2015). In order to govern the energy effectively, individuals must be knowledgeable of the unpredictability of nature to be fully prepared against it. By this knowledge, they can effectively ensure a constant electricity supply with renewable energy.

If people are provided with knowledge of renewable energy, they will be able to diagnose problems whenever they arise and find appropriate solutions. For that very reason, the first thing the participants of TTT did was to study their current energy system. In groups, people went through a handbook written by Ron Hopkins and held regular, self-study meetings. The education gave them the insight that the biggest problem of the status quo was not fossil fuels, but increasing energy demands. It ultimately led them to consider "behavioural changes" the mist important to tackle the energy problem a modern society is facing with. The SV example also illustrates the significance of having wealth of related knowledge. Prompted by the 2011 Fukushima Daiichi nuclear disaster in Japan, special seminars were organised to review the current status of their energy system. The villagers also reached the conclusion that energy demand increase was the issue to be urgently dealt with. They realized that solutions had to include not just changes in technology, but also in institutions, economy, and in society as a whole.

Most importantly, having knowledge allows a dramatic shift in the individual's position in the renewable energy regime. As discussed earlier, in the new institution of the renewable energy, anyone can be an energy producer and supplier. Knowledge is the core foundation of such empowerment since with the knolwedge people can act as affected actors without relying on professionals (Wolsink 2012). The founders of TTT and SV were only laypeople and not energy professionals. Rob Hopkins, the co-founder of TTT, was a permaculture teacher in Ireland and the founders of SV were housewives. But the experience of leading projects and deeply examining energy issues gave them a change to learn about the issue and transformed them into active facilitators, prosumers, makers, organizers, teachers and passionate activists. The new potential and ability of the individuals and households are frequently referred to as "energy citizenship" in energy transition literatures (Devine-Wright 2007).

Building trust through interactions

For the successful collective governance of renewable energy, building trust among members is also crucial. Specifically, sharing ownership based on trust among members of community is essential to sustain the local governance consistently. There is a general consensus in literature arguing for renewable energy as CPR that shifts the ownership from central governments and markets to the local level is vital for effective common governing. But without trust among members, it is difficult for beneficial values - such as transparency, equitability and effectiveness - to take root in their endeavour to promote renewable energy and environmental awareness: distrust hinders effective governing and equal sharing of responsibilities. Dividing the benefits of renewable energy among members could be challenging. As a result, discontent could arise and movement would eventually become scattered and ineffective.

Trust helps the members of any community effectively cooperate and communicate. It is also argued that strong community ties are more likely to settle conflicts among the members in the governing CPRs (Byrne et al. 2009). In addition, positive community relationships ultimately lead to increased trust on renewable energy technologies which is essential to reduce the public resistance to the technologies.

> *Trusting social relationships support and enable cooperation, communication and commitment such that projects can be developed and technologies installed in ways that are locally appropriate. (Walker et al. 2010, 2657)*

In order to build the trust in community, Dietz et al. (2003) argue that it is crucial to share resources and responsibilities equally. However, the scholars suggest that what is more significant are frequent interactions and 'dense social network' among members. Interactive dialogue and strong networking in regards to decision-making, as well as in managing new energy system, can build strongly reliable and trustworthy relationships in the community. A survey conducted by TTT also reaffirms the importance of building a close relationship that is based on trust. The survey result shows that one of the main goals of participating TTT programs was to build relationships with neighbours and more than 70 per cent of respondents answered they had formed reliable relationships with their neighbours (Ashden-awards 2011).

2.3 DIY workshop as New Way of Participation

2.3.1 Workshop based DIY Activity

Workshop based, self-building activities can be seen as a suitable suggestion to meet the two aforementioned conditions of transforming the modern energy institution to CPRs: to provide knowledge on the renewable energy, and to build trust through interactions with other participants. Self-building activities, often collectively referred to as DIY activity (Do-It-Yourself), include diverse activities to create, modify or repair objects without employing professionals (Kuznetsov and Paulos 2010). Historically, the DIY activity has been mainly understood as kind of leisure activity and had not received great attention as an academic research topic.

However, over the last decade, the activity has been gradually popular as an academic subject. Due to the advancement of science and technology, DIY activities involving diverse technologies have been focused in Human Computer Interaction (HCI), STS and in design research fields (Tanenbaum et al. 2013). Low-power FM stations, video productions, civic rituals, community gardens and octogenarian tidal power systems are some examples (Ratto and Boler 2014). Particulary, in the design research realm, the DIY activities are compatible to the term 'object-center' design approaches which focus on how the object helps the integration of new technologies into society (Jalas et al. 2014). The DIY activity has also received a growing interest for 'object-oriented engagement' in environmental issues (Ryghaug et al. 2018) by questioning how the object acts as a medium of engagement in social change toward sustainability.

Such interests are related to the recognition of a critical and politically transformative power of DIY activity to reflect and intervene in conventional system as Ratto stated below:

> *The contributions address making as a "critical" activity, an activity that provides both the possibility to intervene substantively in systems of authority and power and that offers an important site for reflecting on how such power is constituted by infrastructures community and practice. (Ratto et al.2014, 1)*

Basically, the DIY activity is considered an opportunity to assemble a product involving technologies. However as Ratto explicitly stresses above (2011) that a focus of the activity is placed not on the material object but on the act of assembling the object. Having the hands-on experience with technologies helps practitioners understand how the object technically works. More importantly, this activity also amplify a meaning of objects and technologies and expands the comprehension of social issues associated with the particular objects.

The DIY ethos also acts as a democratic agency. Atkinson (2006) affirmed that the creative activity helps practitioners cultivate the self-reliance without depending upon professional aids and creates a more personal attachment with the object. In addition, the DIY activities are largely based on open-source technologies which publicly increase accessibility to those technologies. This means that diverse new technologies and information are available online. Everyone has access to these technologies and people can freely exploit them by sharing ideas and discussing them with others. Accessibility and complete openness provides people a common ground to come up with far more creative and advanced solutions than professionals.

More notably, the workshop-based DIY activities, in which people assemble material objects together, can strengthen togetherness (Atkinson 2006; Ratto 2011) by sharing results and the meaning of the issues of those objects with others. In doing so, the workshop can be "a site of dialogic or discursive for regarding the issues affecting them or their communities (Pidgeon et al. 2014)." Sharing the production process and opinions about relevant issues, through on and offline communities, is more effective to address 'wicked problems' like climate change which have no well-structured definitions but do have diverse possible solutions (Coyne 2005; Ratto 2011).

In light of the transformative and democratic nature of DIY, making activities in the form of workshops can be a new way of participating in renewable energy transition as well as effectively encouraging participants to recognize renewable energy as a CPRs. It is the best place to learn and produce self-sufficient, renewable energy devices in a participatory manner. Having a DIY activity with others also can be a place for interacting with other people and to cultivate a sense of community.

In fact, even though the DIY activities are still not famous topics in academic world, the activities- especially the ones covering renewable energy technologies- are simultaneously taking place around the world. People make rooftop, solar PVs and other small-scale, solar heat collectors. They even go on to share experiences, tips and guidelines through online communities and forums. Finland is not an exception to this movement. Jalas et al. (2014) note that self-building activities involving renewable energy are also emerging in Finland and that schools but a difference is that organizations are taking the leading to spur such activities.

2.3.2 A Comparative Case Study

Outcomes of DIY activities as a new way of participation in renewable energy transition can be distinguished from other approaches, particularly one that is based on the industrial production and business models. *Little Sun* (hereafter, LS) is one of the most well-known examples of how design and art can socially engage energy issues. The LS is a project to promote and sell solar powered lamps designed by a renowned installation artist, Olafur Eliasson. The project was launched in 2012, with an aim to raise awareness regarding energy problems in developed countries and to provide electricity to those with no access to it in developing countries. It's website states their objective as follows:

... Little Sun is a wedge that opens up the urgent discussion about bringing sustainable energy to all from the perspective of art to raise awareness about the unequal distribution of energy today. (Little Sun 2019)

The LS adopts the One-For-One model, which is a well-known social business model. *Toms shoe* company is one good representative example of this. People living without electricity in electricity-scarce nations - as seen in parts in Africa- have an opportunity to buy two solar lamps at cost price for every one lamp that LS sells in developed countries. The LS announced that almost 900,000 lamps were sold, over 500,000 lamps were distributed in off-grid regions. Approximately fifty million dollars was saved (Little Sun 2019) from these sales.

Figure 5 Images of the Little Sun. Left from the website (https://littlesun.com/) and Right by Anton-kurt

Despite the successful outcomes, some have criticized this approach based on industrial production and the business model. Simoniti (2018) expresses doubt concerning the efficiency of LS, compared with the *Liter of Light* (Isang Litrong Liwanag) (hereafter LL). The LL is a DIY light based on simple circuit, open-source and appropriate technologies. In this project, people make the light, and this experience is more likely to give them a chance to understand the electrical system and become empowered to control the products. This outcome is not LS provie the participants. In addition, Ebbesen (2017) strongly criticizes LS project being "a western tradition of patronizing romanticism regarding the development of non-Western cultures (59)."

It is still early to conclude if the approach adopted by LS to renewable energy is not effective. It at least has been quantitatively effective in diffusing the renewable energy. However, the bottom line of the criticisms is that product centred and the business model based solutions are more likely to produce the same dilemmas that the conventional energy system poses. This thesis provides rich discussions on the issues of commodification, dis-embedding from social relation and the limited role of users. As Perovich (2018) urges, the market solutions will misguide people into false sense of participation when it comes to renewable energy:

Product like Little sun may lead us to believe that we can purchase our way out of the energy problem or cause us to feel like we've done our part by buying a lamp, and allow use to avoid looking more deeply at how environmental and social issue are embedded in our society. At the same time, the significant reach of Little sun shows that Olafur was successful in activating a population and channelling their desire to contribute to solving this problem. People want to do something – can we find way to help them do more? (Perovich 2018, 12)

Contrary to the approach based on industrial production and business models, the DIY activities produce various outcomes, especially in terms of the level of public engagement in renewable energy transition. Above all, individual participants can create unique results in the procedure of building renewable energy products, reflecting their own ideas and preferences. This uniqueness enables the participants to build an emotional attachment to the objects made and encourages them to remain active in what they are participating in. Also, DIY activities empower participants and transform them from passive customers to active players. The self-building experiences allow them to acquire abilities to produce, control and organize renewable energy for themselves. Additionaly, it is expected that DIY experiences will give participants more opportunity to intervene in systemic problems in different ways by providing deeper insights into the energy issues. Lastly, the DIY activity in the form of workshop can increase a possibility of collective action in governing renewable energy by providing participants with more chances to interact with others having similar interests.

	Little Sun	Workshop based DIY activity
Model	One-For-One business	Self-building activity based on open-source
Object	Selling Ready-made and industrial product	Providing an experience of making self-sufficient energy generators
Value of Energy	Commodity	Common pool resource
Activity	Consumption	Self-building (DIY)
Users	Customers, Passive end-users	Active actors e.g., energy producers and makerss
Advantage	Quantitative effectivenss Economic benefits	Empowering citizens, An Increase of a possibility of collective action, An increase the social acceptance at local level
Disadvantage	Imitating social dilemmas of conventional energy regimes - Limited role of user, commodification of energy, dis-embedding from social relation	Quantitative ineffectivenss

Table 1 A comparative analysis between Little Sun and Workshop-based DIY activity

2.4 Summary

In this chapter, the diverse literature related to social acceptance, the notion of CPRs and DIY activities have been reviewed to unveil scholarly accounts on why the social resistance to renewable energy has emerged and what alternative approaches are possible to increase public participation in renewable energy transition. The following findings are noteworthy:

First, the social response should be understood as an outcome of dynamic interactions among people, renewable energy technologies and the ways that people participate in renewable energy transition. Until now, social acceptance has mostly been investigated in the light of technical issues, personal preference or highlighted as a one-off event. However, the newly emerged argument on public response perceives public reaction as a flexible phenomenon that changes according to human-energy dynamics and ways of participation in the transition.

In a conventional energy regime, the relationship between human beings and energy, however, appears to be deliberated, institutional and one-way. It is evident that the current energy regime is largely driven by states and markets. While energy has been predominantly perceived as commodity in the current regime, roles of individuals are largely limited to consumption. The commodity-consumer relationship causes several social dilemmas: accelerating commodification of renewable energy; dis-embedding from social relations and significant limitations on the human-energy relationship which will eventually prevent the general public from participating in energy transition. Therefore, this thesis argues that there is an urgent need to reshape the human-energy relations towards more interactive, democratic and diverse outcomes. This would be a crucial prerequisite to increase the social acceptance of renewable energy.

Approaching renewable energy as a CPR can be one of many alternative ways to restructure relationships. The notion of CPRs highlights the importance of collective action in governing common resources which has been largely neglected in the current arrangements to reduce atmospheric carbon dioxide. Approaching the renewable energy as something to be managed in collective manner also enables people perform as active and politically powerful players such as energy producers and makers. This approach will eventually transform the human-energy relationship into one that is more interactive, democratic and active. TTT in England and SV is South Korea are the successful examples of approaching renewable energy as a CPR.

In order to approach renewable energy as a CPR, this thesis proposes workshop-based, self-building activity, which also called Solar DIY Workshop. This is an effective way to empower the participants to be engaged in self-sufficient, renewable energy production by providing knowledge of renewable energy. Also, participants will be encouraged to remain active as they are given a forum to interact with others and act on the environmental issues of their interest in the workshop. Therefore, this thesis will further explore the workshop-based DIY activity as a new model of participation for renewable energy transition. Contrary to the approaches based on industrial products and business models, DIY activities can empower practitioners by providing a place to involve participants in self-sufficient energy production and by building a sense of community through diverse interaction with other participants.

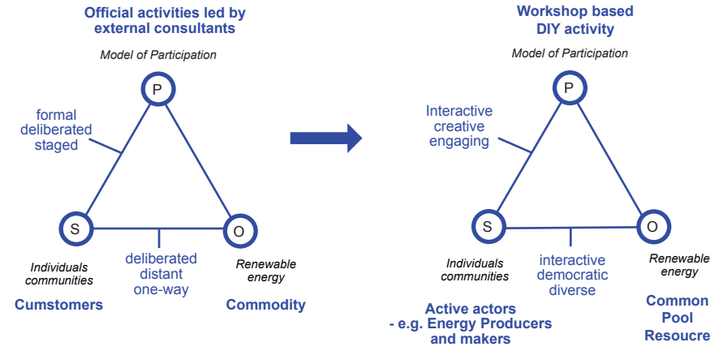


Figure 6 A representation of the perspective on social acceptance of this thesis.

03.

Research Method

The previous chapter drew on a diverse body of theories from social acceptance of renewable energy, CPR and DIY activities, and suggested Solar DIY Workshop to impact participants in recognizing renewable energy as a CPR. In order to clarify the impact of the DIY activity, this thesis employs qualitative research, primarily of action research. Qualitative research is an effective methodology to investigate general understanding and experiences in details on a specific phenomena by exploring behavioural patterns, opinion and emotions (Silverman 2005). Action research is a participatory inquiry to collect this qualitative data. This thesis primarily adopts action research because it is an appropriate method to observe an influence of a certain activity on practitioner's perception regarding issues. However, as explained above, public attitude to renewable energy is inconsistent in many cases. Semi-constructed interview is employed as additional method to obtain more accurate and deeper insight into the impacts of the workshops and participants' perceptual changes on renewable energy.

3.1 Action Research

Action research, also known as participatory action research, is an interactive research method that links action and reflection to produce the most effective practical knowledge to bring about a desired social change in communities (Reason and Bradbury 2008). This method was developed to challenge the way conventional social scientists observe subjects which had been predominantly focused on finding scientific "truth" (Greenwood and Levin 2001). Thus, the prominent aim of action research is to balance theory and practice in generating effective knowledge for mitigation of social challenges.

> *"...research action is about working toward practical outcomes, and also about creating new forms of understanding, since action without reflection and understanding is blind, just as theory without action is meaningless." (Reason and Bradbury 2008: 4)*

Action research has been adopted primarily in educational literature. However, as current "wicked" problems, such as climate change, are "complex, uncertain and non-linear", it needs multi-level and pratical solutions. A variety of social science researchers frequently call for action research to propose a practice-based solution for mitigating the problems (Wittmayer et al. 2013). In this regard, sustainability is one of research communities the importance of practice is growing so that the action research is actively involved in generating knowledge as well as guiding practical action to bring society toward sustainability (Ibid. 2013).

However, action research also has several limitations. Rapoport (1970) reveals three dilemmas: First is "ethical dilemma" which involves the value of issues involved in research; second is 'goal dilemma' which precludes researcher's and client's interests; and last is 'dilemma of initiatives' in which research evolves without considering its clients.

Despite the limitations, action research is the best choice to explore the impact of the workshop in regard to participants' understanding for several reasons. First, action research highlights not only the importance of the practice but also its effects on practitioners' awareness. It also accentuates the importance on the atmosphere where the practice is carried out. Kemmis (2009) emphasizes that the focuses of action research are placed on certain 'practices' of practitioners, their 'understanding' of the practices and 'conditions' that the practices are conducted. Riel (2017) also underlines that the action research enables an in-depth study on certain practices and its effects on organizational context.

In addition, the strength of action research is to capture changeable practices by revealing the configuration of actors in shaping the phenomena (Reason and Bradbury 2008). DIY activity will play out differently each time depending on who participates and with which technology is being undertaken. The application of action research is expected to allow researchers to capture the change during the

self-building activity in each workshop; it also takes note of its impact, which is caused by differences in technologies applied, participants and with the conditions where the practice is taking place.

Action research is also a suitable method for observing how people recognize the importance of collective power. first, this approach generates a participatory process by blurring a boundaries between experts and ordinary people to produce practical knowledge. According to Clausen (2016), the participatory process enables to open free space for communications and to rethink a novel way of action. Moreover, the democratic dimension of action research helps to create cooperation among participants as well as to solve problems of modem society (e.g., solely depending on regulation and privatization). Therefore, applying action research for this thesis is also beneficial to enlighten participants' understanding about collective action in tackling sociel problems our society is facing.

An Iterative Practice Cycle of Action Research

To balance between theory and practice, research needs to be carried out with an iterative practice cycle as illustrated in the following figure. Lewin (1946) suggests the practice cycle consisting of four steps: planning action, taking the action, gathering and reflecting upon findings and applying the findings into a new action. Through the circulated process, researchers can produce more effective practice based abundant reflections. The solar DIY workshop for this research was planned by adopting four steps of iterative practice cycle for action research (1946).

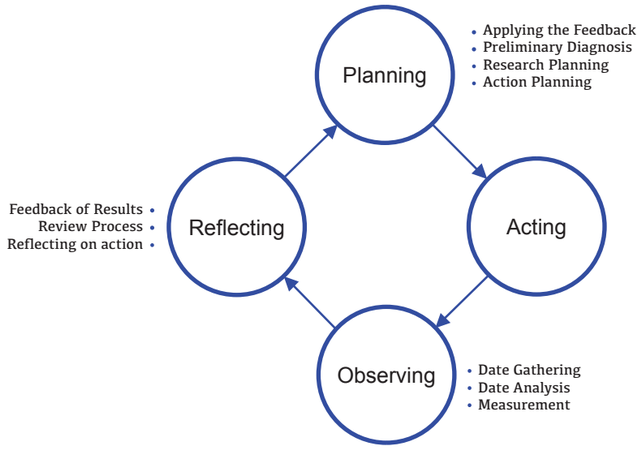


Figure 7 An iterative practice cycle (inspired by Lewin (1946))

Planning

This research began by diagnosing issues of social acceptance of renewable energy and planning a self-building activity as the effective means for increasing public engagement in renewable energy transition. Organizing workshops requires diverse tasks and considerations, for example preparing tools, structuring the workshop and advertising the workshop. The problems of the conventional energy regime have been already identified in previous chapter – the commodification of renewable energy driven by centralization and privatization, which restricts a relationship between human and renewable energy to be deliberated, institutional and one-way. The theoretical exploration of the dilemma of the energy regime concludes that there is a need to shift public understanding of renewable energy toward that of a CPR. In order to address the need, workshop based, self-building activity is organized to bring a change in public perception on renewable energy.

Acting

In the second step, self-building activities, in a form of workshop, are conducted as a case study. This thesis poses two sub-objectives of the workshop to encourage participants to perceive renewable energy as a CPR. The first is to empower participants of the workshop by providing knowledge regarding energy. The second is to allow a chance for communication between other participants. In these steps, it is expected that the participants of the workshops learn how to involve themselves in self-sufficient energy production as well as how to cooperate and interact with other participants. In addition, since action research requires development of practice through the iterative cycle, the building activity of each workshop differs slightly by workshop.

Observing

The third step is to collect and analyse the data obtained by the preceding actions. Basically, data was collected by observation and obtaining feedback from participants. However, in this thesis, the semi-structured interviews are also involved to measure the impact of production activity on the participants' understanding about renewable energy. Because the public attitude to renewable energy is inconsistent in many cases, a additional methodology - which gives an accurate insight into participants' perception on renewable energy - is necessary.

Reflecting

Following step is to reflect upon results of the acting. Collected and analysed data from previous stage can be shared with critical colleagues or participants of workshops. The results of the sharing and reflecting are used to provide a better activity in next workshop.

3.2 Semi-structured Interview

As previously stated, semi-structured Interviews were adopted as an additional method in the observation phase of iterative practice cycle because the public attitude to renewable energy is frequently inconsistent. The semi-structured interview is a method that explores practitioners' awareness and experiences in detail regarding a specific phenomenon (Silverman 2005). The semi-structured interview is an appropriate choice to gain accurate insights into the public understanding on renewable energy because it allows interviewees to openly and freely express their views. The method will aid in exploring discrepancies between the positive public attitudes towards renewable energy technology and what participants actually do in their real lives and why.

Significantly, the interview is conducted by utilizing a mixed form of the questions. It consists of open-ended questions, multiple choice questions and Likert scale questions (0-5). This was mainly because of time constraints. Since the interviews have to take place within the workshop, the interviews were conducted within approximately ten minutes. Adopting diverse forms of questions helped to conduct the interviews in a timely manner.

Especially, the Likert scale questions are used to generate comparative data. They are generally used for quantifying attitudes and emotions in the responses, which are difficult to measure (Boone and Boone 2012). The Likert scale data frequently causes a controversial discussion of whether it belongs to qualitative or quantitative research. For clarity's sake, this method is used to produce the qualitative data in this thesis, accompanying open-ended questions to ask the reasons for their choices in Likert scale style.

Interviewed data is then analyzed using thematic analysis. The thematic analysis is a widely used method for analyzing qualitative data which identifies 'commonly recurring themes' within data (Braun and Clarke 2006). The biggest advantage of applying thematic analysis is that it allows researchers to understand which themes the participant is mostly concerned with related to the topic (Guest et al. 2011). Braun and and Clarke (2006) introduced six phases of conducting thematic analysis:

1. becoming familiar with the data by reading multiple times
2. generating initial code of the date
3. searching for themes which are mentioned multiple times
4. reviewing the themes collected
5. defining the themes
6. producing the report.

The thesis follows these steps to analyse interview data.

04.

Case Study
: Solar DIY Workshop

After having introduced the research method, this chapter illustrates a process of planning and implementing the Solar DIY Workshop. The Solar DIY workshops originally were a part of a course, Personal Project of Department of Design, in Aalto University, in 2017. The workshop was designed and facilitated with Soroush Morardi, a Master's student in Creative Sustainability. Overall, six Solar DIY Workshops were held in different locations across Finland from May 2017 to November 2018 and participants varied in age, background and gender.

4.1 Objective of Workshop

Acknowledging the obstacles of public engagement in renewable energy transition, i.e., commodification of renewable energy driven by centralization and privatization and a limited relationship between people and renewable energy, this thesis concludes that a change in perception of renewable energy as a CPR is necessary. This is essential in transforming the traditional relationship into one that is more interactive and democratic, ultimately increasing the social acceptance of renewable energy. To start to change perception, the Solar DIY Workshop (hereafter SDW) aimed to realize the following goals:

> *To impact on participants to understand renewable energy as a common pool resource.*

Understanding renewable energy as a CPR means that the community as whole should perceive this energy as something they can govern effectively. As stated above, approaching renewable energy as a CPR requires new abilities on behalf of the users: an ability to produce, manage the renewable energy and an ability to cooperate with others in governing the renewable energy. These abilities can be achieved by acquiring the knowledge regarding renewable energy and having a dynamic interaction with others.

Taking these into consideration, two sub-objectives of the SDW are defined as below.

> *1. to empower the participants to govern the renewable energy by providing knowledge for building a renewable energy product.*
> *2. to make the participant to think positively about community-led renewable energy initiatives through diverse interactions among the participants.*

4.2 Target Group

SDW targets people living in rural areas. As stated above, the renewable energy transition needs to be dealt with at the national level, which includes smaller cities in the countryside. However, there are differences among these cities in terms of the accessibility to information regarding renewable energy. Generally, this gap has been seen as a ourcome of difference of technical, physical and financial resources that are applied into renewable energy development between rural and capital cities. However, this thesis assumes that the gap can also occur because of a difference of technical and practical ability of actors between rural and advanced cities. Presumably this difference between technical and practical ability could lead participants to be less active in energy transition involvement. Taking this difference into consideration, the target group of the workshop of rural residents was chosen (Morradi and Park 2017).

4.3 Planning of Workshop

Planning the SDW required diverse tasks and considerations ranged from designing the procedures of production to advertising the workshop. First SDW was planned based on eight questions as follows. The following five SDWs were slightly redesigned by acting upon the observations and insights gained from previous workshops.

1. What to make?

Solar PVs, of renewable energy technologies, was chosen. The solar PV is a leading clean energy source to reduce the man-made CO2. Its use reports the most rapid growth and reasonable price rate (REN21 2017). Due to its high accessibility and affordable prices, solar PV has been largely promoted in many countries and has become the most conspicuous energy technologies. The other reason to choose solar PV is that building a Solar PV generator requires only a few components (e.g., a charge controller, a battery and an inverter). The procedure of assembling solar PV products is less demanding for amateurs. Before becoming involved in the SDWs, participants were able to choose a product to make from two possible options: solar PV chargers or a solar PV lights. Both products are practical in modern life so that participants would be highly interested in the products and use them on a daily basis.

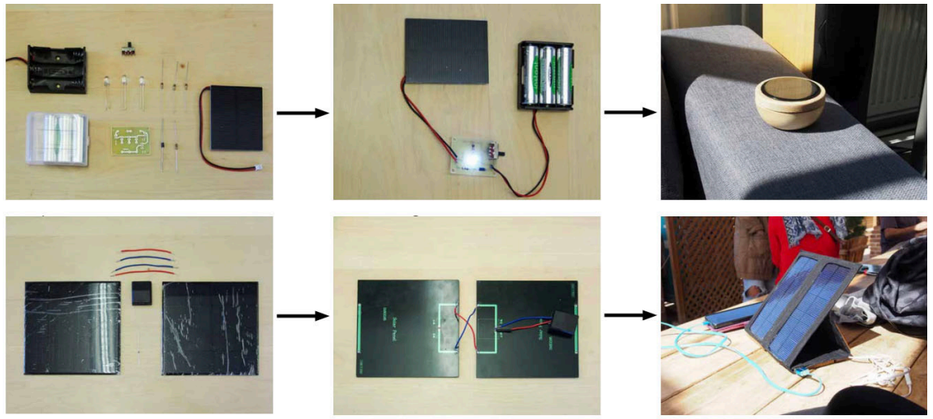


Figure 8 An image above, a solar PV light. An image below, a solar PV charger

2. Components Involved?

Building solar PV lights requires a panel (0.5W, 5V/100ma), Battery (2000Am), LEDs and a charge controller. The components of solar PV charger are two panels (each 4.5w, 6V/ 750ma), a diode and a charge controller. At first, we looked for the components exclusively in Finland. However, there were not enough electrical stores that sold the components. We had to order most of the components from other countries.

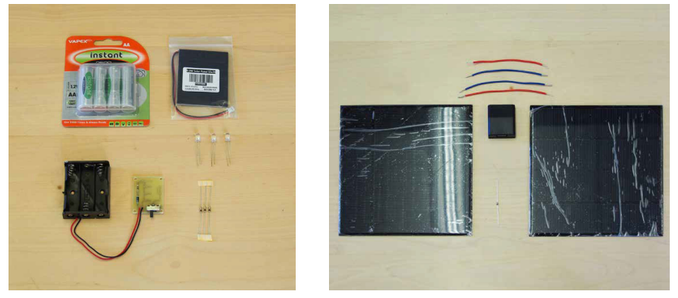


Figure 9 Left. Components of solar light, Right. Components of solar charger

3. How to communicate with participants?

One of the biggest concerns in planning the first workshop was the language barrier. This was because we assumed that participants in rural areas were not fluent in English. Because of this, we decided to conduct the workshop mainly in English but also prepared printed materials in Finnish. Most workshop contents were interpreted in Finnish as seen in following images. The procedure of the making solar PV products was also illustrated with images and text. We also invited Finnish native speakers to attend the workshop: one was the energy expert living in Lohja; the other was a student studying on Art Education in Aalto university (Moradi and Park 2017).

Figure 10 Images of prints of the workshop

4. What information would be delivered?

As explained above, providing knowledge of the uncertainty and intermettency of renewable energy is important to help participants manage it more effectively. In this workshop, several subjects about the uncertainty and intermettency of renewable energy were addressed: biased views, challenges of current energy systems and limitations of solar energy in Finland. These are to increase the understanding of renewable energy and remove prejudices about those technologies. It would eventually help participants to manage and apply the knowledge effectively.

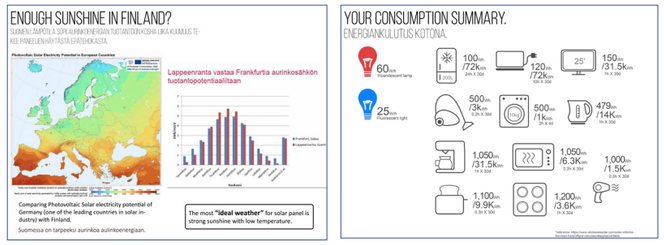


Figure 11 Slides of presentation of SDWs

5. How to Advertise?

In order to advertise the workshop, online and offline methods were used. We made A4-sized flyers to provide information concisely and clearly to the public. The flyers were available in English and Finnish so as to appeal many people as possible. We hung the flyers on bulletin boards in public spaces such as local libraries and club houses. Advertising with social media could be more effective to reach other sorts of people compared with advertising with the flyers only. We created an event page on Facebook to attract attention of those who are more active in social media but less active in public spaces.

Figure 12 Advertisement flyers

6. How to enroll?

The participants were required to enroll in the workshop in advance because we had to prepare the space, tools and components based on the number of participants. They were able to enroll by email with their names and contact information in case of urgent cancellation. Once enrolled, they were provided with options on which solar PV products they would like to choose: solar chargers or lights.

7. How to encourage diverse interaction among participants?

Active interaction among participants is one of essential goals of the workshop as illustrated above. Thus, the workshop was designed to increase interactions. For example, people were divided into two groups depending on what product they chose to make: solar chargers or solar lights. Two people were given one set of tools to share. Especially for soldering work, participants were encouraged to collaborate with each other. For example one participant had to hold the wire and the other had to use the soldering tool. Online communication was another way to increase the interactions. Participants can share images of their final products and uploaded their questions to online communities– Facebook group, Solar PET.

8. Structure of the Workshop

Consequently, the workshop consisted of five phases, and the structure of a two-hour SDW is illustrated below.

Before workshop	Enrolment		Registration Selection of product: chargers or lights
During workshop	Providing knowledge	Introduction	Facilitators - Why we hold the SDW Participators - Why they participate
		Information session of renewable energy	Introducing the purpose of SDW Biased views Challenges of current energy system Limitations of solar PVs in Finland
	Self-building activity	Making a Solar PV product	Explaining basic principles of solar PVs Making solar PV products Cooperating with other participations
	Testing		Testing the products they built outside under the sun
After workshop	Sharing		Asking questions and sharing final image of the products in Facebook group page

Table 2 The structure of SDW

4.4 Implement of Workshops

Overall, six SDWs took place in different regions in Finland from 2017 to 2018. Each workshop had different types of participants, places and atmospheres. As action research occured, every workshop recorded slightly different responses from participants, and the observations were applied to the subsequent workshop to improve the activity experience.

First Workshop in Lohja

The first Solar DIY Workshop was held in city of Lohja. We choose the Lohja for the first SDW becuase Lohja is also a rural area where ordinary Finnish people live and where we could observe their understanding of Solar energy. At the same time, it is located near Helsinki, where two of the facilitators lived.

Nineteen people in total participated in the first workshop. Surprisingly, the participants were from a wide range of age, background and gender. A child, who was around 5-7-years old was our youngest participant who came with his father to make a solar charger; a mother and daughter also joined the workshop and helped each other. Participants worked quietly, but actively participated in the workshop. They asked a lot of questions and shared their ideas regarding renewable energy. We found that some participants who had knowledge about electricity helped the others. After completing their projects, each participant tested the solar PV product they assembled under the sun. When they saw that it worked well, they were surprised about basic principles of solar PVs as well as a fact that their device actually produced energy. One participant responded that it was something they never experienced before.

Reflections from the First Workshop

- Received overall good responses
- Some of the participants were struggled to understand the assembly process, so they asked us to further explain basic principles of the electricity.
- A need for some different examples when explaining about voltages that PVs produce and that how this varies according to PVs size.
- Supplemental visual materials and explanations were necessary because what was provided was not sufficient.
- Generally, most participants spoke English well.
- The participants needed more time to complete the products they made.
- A further interest in SDWs resulted from residents who lived in other cities and heard about the workshop.

Figure 13 Pictures of the first SDW in Lohja (Photo by Dan Palarie)

Second Workshop in Helsinki

For the first SDW, we targeted people living in rural areas. However, we found that there was also high interest in the self-building activity of renewable energy in Helsinki city. Thus, we decided to hold the next workshop in Helsinki.

Second SDW was held on September of 2017 in Turntable of Dodo organization. (Kääntöpöytä, Dodo). Dodo is one of Finnish environmental organizations focused on diverse local and global environmental issues. The Dodo was founded in 1995 and had already initiated many such activities at the community level. We asked them to provide the venue for the workshop and they were willing to do so. They also helped us to advertise the workshop by sharing flyers with volunteers and members of their organizations. Thanks to their support, eighteen people came to the workshop. As we expected, there were more international people than were at the first SDW. The basic setting of the workshop was the same as the first workshop; a set of tools were given to two people and each person was encouraged to cooperate with a person sitting in front of them. After the workshop, participants tested their products under the sun.

Reflections from the Second Workshop

- More attention is required when soldering because it is too hot.
- Participant attitudes about renewable energy seemed more positive when they saw that their chargers were actually producing electricity under the sun.
- An increasing interest toward SDW resulted from other organizations.
- Making a solar PV charger was more popular than building a solar PV light.

Figure 14 Pictures of the Second SDW in Helsinki (Photo by Houman Taleghani)

Third Workshop in Joensuu

After previous workshops, even though the SDW was a small-sized workshop with simple methods, we received favorable responses from participants and organizations associated with environment and sustainability. One of notable achievements was that third workshop was conducted with support from Suomen ympäristökeskus. (Finnish Environment Institute, SYKE) Thanks to support by SYKE, the third SDW took place on 23th September 2017 in a classroom of University of Eastern Finland. An employee of SYKE, who also worked in University of Eastern Finland, supported us during the workshop ; she assisted by reserving the venue and taking pictures. Fourteen people participated and most of them were students of University of Eastern Finland. The same structure of SDW was applied at the third workshop.

Reflections from the Third Workshop

- A need to upgrade the capacity of PVs because it took too much time to charge a phone with current solar PV products.
- Participants communicated that they wanted to be provided a cover for their solar PV charger in the workshop.
- It seemed that testing the product under the sun was essential to change participant perceptions of solar PVs.
- People prefered making solar chargers to solar lights. Some participants chose to make the light because of limited availability of solar PV changer components.

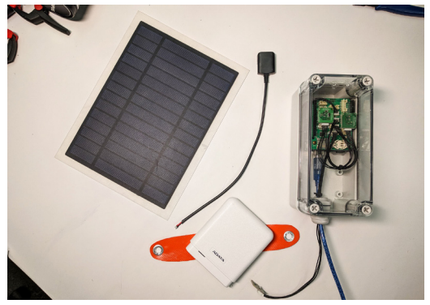
Figure 15 Pictures of the third SDW in Joenssu

Fourth Workshop in Helsinki

The fourth workshop was also done with support from SYKE. SYKE was previously planning a project to build sensor boxes charged by solar PV chargers. The SDW was invited as part of this project to teach how to make solar PV charger. Since the SDW was a part of another project, new tasks were given by SYKE. The tasks were as follows:

- To educate teachers involved in the workshop about how to make a solar charger with solar PVs. After this, the teachers were expected to direct their students in the same activity.
- The solar charger should produce certain amount of energy enabling operating a sensor box for a day without employing other energy sources.
- The charger should be higher water-resistant.

In order to meet the new requirements, the solar DIY activity needed to be redesigned. PVs were upgraded so that they would produce more energy to operate a sensor box without depending on traditional, on-the-grid power. In addition, the production of a battery and water resistant cover was added to the DIY activity.



Upgraded components:
A panel (5W, 7V/ 0.65A)
A battery (10,000mAh)
DC-DC step up converter
(6-18 input, 5V, 2A output)
Diode (max 1A)

Figure 16 Upgraded components of the solar PV charger for Fourth workshop

The biggest challenge of these new objectives was to design a weatherproof cover for the charger. Because the sensor box was intended to be installed outdoors, the solar charger also needed to be operational under all weather conditions. Thus, it needed to be heavy-duty, easy to handle and water-resistant. At the same time, the cover had to be sustainable. As a result, we chose to use recycled tarpaulin which is commonly used for covering trucks. We tried to contact several tarpaulin retailers in Finland and one of them provided used tarpaulin for SDWs.

Figure 17 Image of the Tarpaulin

The workshop took place in SYKE headquarters in Helsinki, in January 2018. The participants were twelve teachers that came from all around Finland - Jyäskylä, Rauma, Lohja, Turku and so on. They did not know each other but actively cooperated with each other. In order to teach their students after returning to their schools where they taught, they cautiously recorded all the steps of making the solar PV charger. After the production session was completed, we answered many questions such as where participants could purchase different size of PVs and how to build the rooftop PVs for their summer houses.

Reflections from the Fourth Workshop

- Tarpaulin was a good material; however, it was hard to handle for some of the participants.
- For ice breaker, introducing themselves was a good idea.
- We needed to encourage participants to feel more free and creative in production because some of them became stressed when they could not exactly follow the assembly steps that facilitators had suggested.
- The need to add Velcro to attach the charge controller to the cover.
- If all participants made the same product (solar PV charger), it was easier for them to concentrate in making.
- More and more people inquired if they could buy the DIY kits in the market.
- We needed to find a more effective way of delivering the instruction because the printed instructions were not adequate for a two-hour workshop. The easiest and most suitable means seemed to be showing an instructional video.

Figure 18 Pictures of the fourth SDW in Helsinki

Fifth Workshop in Jyväskylä *

One of the participants of fourth workshop invited us to host the next workshop in their school in Jyväskylä. He was a biology teacher and wanted to share the DIY activity with his colleagues. Overall, fifteen teachers from Jyväskylä and neighbouring regions came to the fifth SDW.

Prior workshops were held in places not intended for the self-building activity. However, the fifth SDW took place in a actual workshop which was an ideal place for DIY production. The workshop was equipped with various tools and big tables. In addition, one of the participants was a technician from the facility who helped other participants by showing them the proper way to handle tools. He also provided extra materials.

For the workshop, a new instructional video was introduced and we encouraged participants to be more creative and free in their procedure of production as the facilitators suggested. In the beginning of the workshop, some of the participants kept asking which was the right way to make their item. We tried to encourage them to make it in a way they wanted. Consequently, final products were very unique, different and creative, reflecting each one's idea. Some of the products created were superior to the facilitator's product. For example, one participant wanted to put Velcro in different way and it was more effective and advanced than the method that the facilitators had suggested. In addition, one participant who made a mistake in his production refused to accept a new DIY kit (to start over) because he thought the mistake was a innovative part of his design.

Reflections from the Fifth Workshop

- Found that even participants of previous SDWs could be organizers of following workshops.
- The participants could be far more creative in production beyond our expectations.
- In some cases, they created better devices than those made by facilitators.

Figure 19 Pictures of the Fifth SDW in Jyväskylä

* For reasons of health, I could not participant in the workshop as facilitator. The explanation of the workshop was written based on remark of other facilitator, Soroush Moradi.

Sixth Workshop in Espoo

The sixth workshop took place as a part of Espoo Wärk:fest, in October 2018. Espoo Wärk:fest is a Maker Faire which takes place every year in Espoo city. We decided to participate in the Faire to meet diverse people interested in DIY and renewable energy as well as to interact with other makers. Overall, thirty-eight people made solar chargers in our workshop. This workshop was slightly different in terms of the process when compared to previous workshops. People passing by our venue were able to participate in the workshop without enrollment. Since almost half of participants were family members with children, the options of of sharing tools and helping other participants were reduced. However, cooperation between family members and friends was increased. Another difference - compared to the other workshops - is that makers, who already had knowledge and experiences on renewable energy, were actively involved. They also helped us explain how the solar PVs works to younger participants.

Reflections from the Sixth Workshop

- We had too many participants compared to the prior workshops. This workshop did not fully meet the objectives of SDWs
- It was very difficult to interact with participants compared to previous SDWs.
- An increasing request to purchase the kit in market – some wanted to give it to their friends as Christmas gift, while other wanted to try it as a family activity.
- The interaction with other makers inspired us and gave many new ideas about the workshop.
- Experts of renewable energy enjoyed building solar PV products because they also rarely had hands-on experience with renewable energy technologies.

Figure 20 Pictures of the Sixth SDW in Espoo (Photo by Houman Taleghani)

4.5 Summary of Workshops

The workshops took place in six different locations in five cities of Finland. We had over one hundred participants. Diverse partners were involved in holding the workshops: regional governments, private companies, non-government organizations and governmental organizations. The results of the six SDWs are summarized as below.

	Region	Venue	Date	The number of participants	Sponsors
1	Lohja	City Library	6 May 2017	19	Novago, City of Lohja
2	Helsinki	Kääntöpöytä Greenhouse	15 Sep 2017	18	Dodo organization
3	Joensuu	University of Eastern Finland	23 Sep 2017	14	SYKE Maaseudun Sivistysllitto
4	Helsinki	Suomen ympäristökeskus (Finnish Environment Institute, SYKE)	24 Jan 2018	12	SYKE, Tarpaulin
5	Jyväskylä	Workshop in Kilpisen yhtenäiskoulu	25 May 2018	15	Kilpisen yhtenäiskoulu
6	Espoo	Ison Omena library and Palvelutori, Espoo wärk:fest 2018	18 oct 2018	38	Espoo wärk:fest 2018
	5 cities	6 locations		116	

Table 3 Summary of six SDWs

Final Images of the Products Shared Through Social Media

At the end of SDWs, participants uploaded pictures of their final products to social media in order to communicate among participants even after the workshop. Later, some participants uploaded final images of the products with covers that they designed in Facebook group as seen below. However, after providing tarpaulin for the charger covers in the SDW, no one shared the results of this in social media.

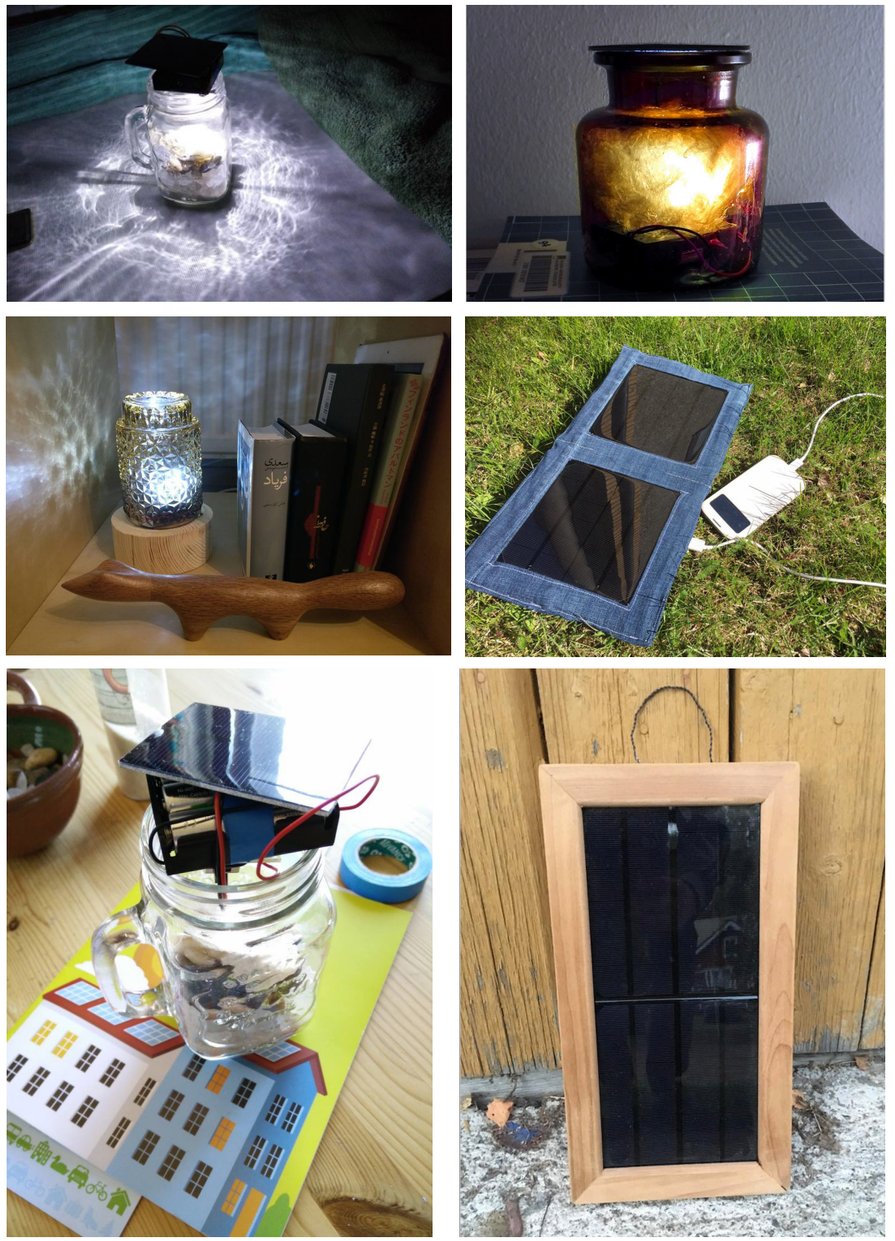


Figure 21 Final images of the products shared in social media

4.6 Reflection of Workshops

Participants from Diverse Backgrounds

Before organizing SDWs, we assumed that most participants would be predominantly male adults interested in DIY activities. However, the participants actually were from a wide range of ages, nationalities, genders and professions. A 5-year-old boy, for example, seemed to be our youngest participant who came with his father; a mother and daughter came to the workshop together and helped each other. Moreover, even some participants we interviewed had expertise in renewable energy, e.g., a master's degree student and a professional researcher of renewable energy.

Positive Attitude Towards Solar Energy

Most participants showed a positive attitude toward solar energy while participating in SDWs. Significantly, the positive attitudes toward solar energy were more evident after participants verified that the solar PV product they assembled was able to produce electricity under the sun. After the self-building activity, every participant had a time to test the solar PV products outside. When they found that the handmade solar PV charger worked, they were impressed about the straightforward and easy procedure of building solar PV products. One of participants of fourth SDWs invited us to organize the fifth workshop because he wanted to share the experience with his colleagues.

Cooperation with Diverse Partners

All SDWs were conducted in cooperation with diverse partners (e.g., regional governments, non-governmental organizations and private corporations). Each one helped us to hold the workshops successfully in many ways. For example, a Novago entrepreneur based in Lohja helped us find a workshop venue, solved the financial difficulties and addressed language barriers. Dodo also provided a conservatory and helped with advertising the second workshop. In addition, some organizations gave a material support. For instance, SYKE supported two SDWs – third and fourth SDWs - by providing material fees, design fees and travelling fees. The company, Tarpaulin, also contributed reusable tarpaulins for us to use.

Creative Participants Over Production

Some participants were far more skilled and creative in making the solar PV products than the facilitators expected. Before organizing SDWs, we presumed that for those with no prior DIY experience, building solar PVs charger would be demanding. However, most participants were good at handling the tools and making the devices. Some of the participants were extremely creative in making the solar PV products as seen the final images of Solar PV products that they shared through the Facebook group. One participant in fifth workshop also suggested a far more advanced solution in making chargers, e.g., how to put the velcro in the charger cover.

Evolving the Practice of SDW by Workshop

As illustrated above, every workshop slightly idiffered n terms of type of participants, places and partners. Those differences also impacted the DIY activity, from the components, production procedures to instructions involved. From every workshop, we received valuable feedback and commentary from participants and partners. For example, we received important comments from the participants of third SDWs regarding the need to upgrade the PV panels of the charger, the need to provide a cover of the solar PV charger and the need to allow more seating to make solar PV charges. Those suggestions were implemented in the following workshops to provide a better activity. As result of it, the Solar PV charger was upgraded to produce more energy and the water-proof cover, made of tarpaulin, was added to the package. The education of participants on how to build a solar PV charger also progressed compared to the educational procedure utilized in the first SDW. And because there was little interest in building solar PV lights, the light building activity was excluded after the third SDWs.

An Increase Interactions Among Participants

Most participants at the SDWs were friendly and team players. The workshops were intended to encourage participants to share tools and work in pairs. While some were hesitant when they had to share the tools with strangers, most participants were willing to help each other actively. The overall atmospheres was friendly and warm. However, when participants came with friends or family members, it was difficult for them to communicate with new people. Online interaction became even less involved than what we observed in the workshops.

05.

Measurement of Impact of Solar DIY Workshop

The previous chapter presented how the SDWs were designed and implemented to influence participants to understand renewable energy as a CPR. The next chapter illustrates how to conduct semi-structured interviews and obtain research findings to measure the impact of SDWs accurately. As stated above, because of inconsistency in public response toward renewable energy, this thesis also employs the semi-structured interview method to measure the extent of impact that SDWs had on the workshop participants. The interviewed data was recorded according to interviewees' consent and was transcribed. The transcribed texts were then analysed using thematic analysis.

5.1 Selection of Interviewees

In total, fifteen interviewees were recruited for the interviews. The interviewees were randomly selected from different SDWs. There was no age, gender, nationality or job restrictions set for the recruitment. In order to ensure anonymity and confidentiality of the interview participants, the names were kept anonymous.

	Workshop participated	First letter of name	Gender	Profession	Nationality
1	First	A	F	researcher	Iran
2	First	M	F	teacher	Finland
3	Second	H	M	designer	Japan
4	Second	H2	M	designer	The Netherland
5	Third	M2	F	research	Finland
6	Third	J	M	entrepreneur	Finland
7	Fourth	L	M	engineer	Finland
8	Fourth	I	F	student	Finland
9	Fifth	V	M	teacher	Finland
10	Sixth	L2	F	librarian	Taiwan
11	Sixth	J2	F	researcher	Spain
12	Sixth	C	F	teacher	Finland
13	Sixth	L3	M	librarian	Finland
14	Sixth	B	M	engineer	Singaporepore
15	Sixth	D	M	engineer	Finland

Table 4 A list of the interviewees

5.1 Conducting Interviews

The interviews took place before and after workshop sessions in order to gather comparative data. Only one interview with a participant of fifth SDW was conducted a week after the workshop because of researcher's absence in the workshop. Thus, fifteen pairs of participants were interviewed and data was collected after the thirty interviews that were conducted. The interview questions comprised of three themes: participant's understanding on solar energy; personal involvement in self-sufficient energy production; and involvement in community level activity. For the pre-workshop interviews, the interviewees were asked to explain their understanding, knowledge, and experience of the solar energy. Post-workshop interviews focused on asking if there have been any perceptual changes regarding renewable energy.

Each interview took around ten minutes, on average. The interview consisted of open-ended questions, multiple choice questions and Likert scale questions (0-5) followed by open-ended questions asking or the reasons of their choice. The prepared interview questions were given to the interviewees, but following topical trajectories were also permitted to point up new topics. Two pilot interviews were conducted to verify the relevance and appropriateness of the interview questions to the topic as well as research ethics. Thereafter, formal interviews were undertaken and the participant data was analyzed using thematic analysis.

5.3 Interview Findings

5.3.1 Growing Interest in Renewable Energy

The clearest finding from the interviews is that SDWs considerably encouraged participants' interest in renewable energy. Although they were working with only solar PVs in SDWs, their interest expanded to other types of renewable energy technology. Before participating in the SDWs, While only two people previously had DIY experiences related to renewable energy technology, thirteen people responded that they had heard about renewable energy but had not built solar PV products for themselves. This was because they were not interested in renewable energy. In the post workshop interviews, however, the responses were positive towards making a broader commitment to renewable energy:

Before I wasn't interested in this thing at all, because I have not had any chance to think about it in my life. (M)

Yes, I wasn't interested in before but doing it increased my interest on the renewable energy. I think I am going to give more attention when I read news about renewable energy things. (J2)

I am also interested in other types of renewable energy. I want to borrow some books related to the topic, read those and also googling. (V)

Also, the interviewees asked many questions of facilitators in the follow-up interviews. The questions they most frequently asked was where to buy building components in Finland and which solar PV panels would be better for use in their summer houses. Both questioned showed their increased willingness to consider alternative electricity sources. Interestingly, they also asked about disadvantages of renewable energy. Some interviewees were curious about limits of the renewable energy such as a possibility of recycling solar PVs and an ineffectiveness of solar PVs during certain seasons in Finland:

What if it (Solar PV panels) winds up? Where would it go? If somebody throw this away? (C)

Yes, I want to also know how to make wind power. Because in Finland I think solar energy is working well in summer but it is too short. So I think during fall and winter, it might be better to use wind energy. I also want to google or find more information in Youtube. (H2)

5.3.2 Users as Energy Producers and Makers

As Table 5 exhibits below, the assembling activity allowed the participants to perform as energy producers and makers rather than as customers. In the pre-interview before participating in the SWD, thirteen out of fifteen interviewees described themselves as customers. Only two of them identified themselves as makers who already had experience of making solar PVs for their summer home or in university projects before the workshop. The participants also expressed belief that producing solar energy was an industrial and professional practice which ordinary people could hardly involve themselves with. However, after building solar PV products, all of the interviewees recognized themselves as energy producers and makers. They also appreciated the possibility of having personally owned solar products and the importance of owning such renewables for maintaining their everyday lifestyle. One interviewee reported that the production activity allowed people to have a personal attachment to the solar products they had built. It seems that the change in roles of users was related to a transformation of thought. Participants recognized that ordinary people could produce and manage renewable energy by themselves.

The role of Users	Before SDWs	After SDWs
Consumers	13	0
Energy Producers or Makers	2	15
Open-ended Responses	0	0

Table 5 Comparison of interview results on the role of users

Solar panel is everywhere but not personal one. (…) I think it is very rare to have personal panels. (…) motivation was it seems interesting for me to have a personal solar panel. (H)

I always thought that solar panels are belonged to those farms and big industries and people cannot use it. (…) when I have heard about your workshop, people also can themselves make their panels and the energy. (A)

I did not know that those kind of energy thing is really being connected with my life. But now it is really connected to my life. I think we need also other approaches to the energy crisis. Maintaining energy use needs to be lower. (M)

I did not know it is possible, I thought somebody else had to do it. (C)

By making the panel myself, I have more feeling of attachment to this, then I want to use more often. (J)

5.3.3 Increasing a Possibility of Building Solar PV Products Afterward

Most interviewees found assembling solar PV products was easy and it seemed that the uncomplicated procedure made the participants to feel more confident, active and involved in self-building, renewable, energy productions. One participant explained that making a solar PV charger in the workshop was easier than making electric devices back in his junior high school in Finland. Two of the interviewees were experts in renewable energy and they also stated that the activity was exciting for them since even as professionals in renewable energy, they rarely had hands-on technical experiences with such devices:

> *Making part was very exciting. (…) It was not really complicated to make. When I somehow understand little bit the system of the panels, connecting components is very interesting. (M)*

> *I am specialized in renewable energy technology. But we did very little hands on stuff (B)*

> *By doing that, I could more understand the system inside. It was also not very difficult so it surprises me that actually making energy is easy. Using energy is always easy but electricity seems something I cannot access to and it require some technical or professional knowledge and skills. (…) I think behaviour change is not demanding anymore. I think I would be more excited to charge my phone with the panel. I am actually waiting for sun to use my panel. (H2)*

The undemanding, assembly procedure also increased self-confidence in making solar PV products. When the participants were questioned on how confident they felt about making a solar PV again on their own, nine people answered they felt perfectly confident after the workshop, while only two people answered with 'highly confidant' before the workshop. The impact of SDWs was significant when looking at the drastic decrease in number of people who answered that they had no confidence at all. That number dropped from eight to zero.

The Level of Confidence in Making	Before SDWs	After SDWs
5	2	9
4	1	4
3	1	1
2	0	2
1	2	0
0	8	0

Table 6 A comparison of research results based on levels of confidence in making solar PV products.

The interview participants came up with various creative ideas as to what solar PV products they wanted to make afterward. Some answered that they wanted to make a new phone charger by adding more panels; others wanted to make a solar light in different shape; and still others wanted to build solar PVs for a summer house or a sailing boat. However, they were also aware of difficulties involved in bringing those ideas into fruition despite the level of confidence they showed. Several respondents pointed out that purchasing necessary components is challenging in Finland. The extra efforts that were required to purchase products online could easily become a source of discouragement:

> *If I feel so (to make a new solar PV product), if I get components, cable, panels. (H)*

> *I would like to, but getting all components for making it would require some efforts and time to order those from China. Especially Tarpaulin and diode. (L)*

Furthermore, the uncomplicated procedure of assembling was likely to bring behaviour changes regarding energy use. Generally, using solar PV panels requires different behaviours than the use of conventional energy sources which are based on 'plug-and-forget' basis. Two questions regarding the possibility of behaviour changes were given to the interviewees with examples. The first question asked if the user should take the PV products outside to charge them when there was strong sunshine. Before participating in SDWs, only three interviewees wanted to leave the building and go outside to charge the charger. After they had assembled the product, however, they were more willing to make the extra effort to go outside and interact with the solar energy. When the workshop experience was completed, twelve interviewees wich changed their behaviour.

The Level of Possibility of behaviour changes	Before SDWs	After SDWs
5	3	12
4	4	2
3	6	1
2	1	0
1	1	0
0	0	0

Table 7 A comparison of interview results concerning the possibility of behaviour change related to energy use.

The second behaviour change addressed the willingness of participants to power their homes with renewable energy. The majority of the interviewees responded that they were seriously considering a replacement for fossil-fuel based energy sources used in their homes. They opted instead for a self-sufficient, renewable energy source. During the pre-workshop interviews, only three interviewees showed strong willingness to replace these energy sources. However, after the production activities, seven people chose self-sufficient renewable energy sources as a their preferred option.

The Level of willingness to power homes with renewables	Before SDWs	After SDWs
5	3	7
4	8	7
3	3	1
2	8	0
1	0	0
0	0	0

Table 8 A comparison of research results on willingness to power homes with renewable energy

But what I am thinking now is that maybe I should check where our electricity comes from. My boyfriend is who decided the electricity stuff, where it comes from, how much more would cost if we change to more renewable energy and then consider that is worth price. Because we do that with food really easily. This organic and this is Finnish food we do that. Even though we know it is small and expensive, we prefer Finnish cucumbers. So it is something we should consider in that way. But until now, I have been so lazy that. (M2)

5.3.4 Encouraging Interactions Among Participants

It was also found that SDWs gave participants a chance to interact with other participants. Two of participants described that in workshops they had previously attended, people in general worked alone with given supplies. Sharing tools with other participants was rare. Therefore, working collaboratively and sharing tools in a workshop came as a bit of surprise to some participants. As soon they came to terms with the cooperative nature that underlies the SDWs, they conversed and worked with others that they did not have previous connections with. In the end, the participants made positive remarks that the overall atmosphere of the workshop was friendly and warm. One of the responses stated that there was a difference between the self-building workshop and other typical workshops in terms of the level of participant motivation. She found that the participants of SDWs showed higher motivation to be involved in the workshop, compared to other workshops she had previously been attended:

It was a great idea. Nicer to works in pair. It is always nice to have company. It is not really common in Finland doing something together. We used to do our own project not talking with others. (V)

I have been living in this area for two years but I have little contact with my neighbours. It was nice atmosphere in workshop so that I was more relieved to talk to people around me. I think making something together is somewhat helping people to be more open to others. (H2)

It (sharing tools and helping each others) was not very a common situation, I guess, that is because they really wanted to come and learn something about solar energy. For example, in workshop in workplace, people are not that motivated. But in today's workshop, people looked very motivated. Feeling was very nice. (M)

5.3.5 Still hesitating to be part of collective governing the renewable energy

Nevertheless, about half of the interviewees still showed hesitation in participating in community-led renewable energy initiatives. According to the result of a scale question demonstrated in Table 9, thirteen out of fifteen interviewees showed great willingness to participate in citizen-led renewable energy initiatives after the SDWs.

The Level of willingness to participate	Before SDWs	After SDWs
5	1	3
4	3	10
3	6	2
2	3	0
1	2	0
0	0	0

Table 9 A comparison of research results of willingness to participate in citizen-led renewable energy.

However, when participants were asked a following open-ended question on why they wanted to participate in the activity, of the thirteen people, seven still showed a certain degree of skepticism because they lacked of information on and were unfamiliar with the community-managed, renewable energy:

Yes, that is really interesting. Probably we want to know what is benefits of participants of the projects. (H)

I would still be a bit worried that community run project would end up being a hassle. (M2)

That sounds interesting but I need to know more about that. Now since I don't have enough knowledge and information about solar energy and citizen-led renewable energy initiatives, it is hard to make a decision. (H2)

5.3.6 A Strong Belief in Government Responsibility

Interestingly, the level of trust in the role of government leadership in renewable energy transition remained the same. After the SDW sessions, interviewees began to recognize the importance of the role of community and people in renewable energy transition. However, there was little change in the perspective of interviewees that governments should take a bigger responsibility than the market, community and people for renewable energy transition. One response argued for the strong control by governments and markets because of selfishness of people.

The level of responsibility	Before SDWs				After SDWs			
	Government	Market	Community	People	Government	Market	Community	People
5	12	4	1	3	13	6	7	8
4	3	8	10	10	2	6	6	5
3	0	3	4	0	0	3	2	1
2	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Table 10 A comparison of research results on responsibility of actors for renewable energy transition.

I think Government. Government has a lot of budget for change everything. Support many things include market. I have no idea about it. Market is also important. If there are really good product of solar panels. Market is also important as movement. (H)

I because right now the market is things doing an impact but individuals are selfish and they are implementing when it is portable, easy and just standard thing to do. And government should be pushing that we have a planet to live on. (J2)

5.4 Summary of Research Findings

The results from the interviews showed that participation in the SDWs considerably stimulated a positive attitude of participants toward renewable energy. Particularly, the participants' positive attitude was more evident when they experienced two aspects of SDW. First, when they experienced the uncomplicated procedure of assembling solar PV products, self-confidence in the activity increased and their attitudes toward solar PVs became more positive. Second, when testing the solar PV products, participants' attitudes toward solar PVs transformed into more positive ones.

Needleless to say, participant interest in renewable energy largely expanded. Participants' interest was not just limited to the advantages of having a renewable energy product. The participants also became concerned about the disadvantages of renewable energy products (e.g., a possibility of recycling the solar PVs and the ineffectiveness of solar energy in certain seasons in Finland). However, it seems that recognizing the drawbacks of renewable energy did not discourage people from participating in self-sufficient energy production. Even though they recognized the limitations of renewable energy in mitigating CO_2 emission, almost all respondents were willing to make new solar PV products afterwards. One of the respondents made positive remarks that participation in the SDWs motivated her to become more involved in the workshop, compared to other workshops she had previously been involved in. Furthermore, the self-building activity with renewable energy brought about participant behaviour change in energy use. During the follow-up interviews, a number of interviewees were seriously considering the introduction of power their home with renewable energy sources and were willing to adopt behavior change in order to use the Solar PV products they had built (e.g., take the PV products outside in order to charge it when there is a strong sunshine).

More notably, all participants were able to assume different roles, for example, as energy producers, makers and organisers of the DIY workshops. It seems that the change in roles of users is related to a transforming recognition: ordinary people can produce and manage renewable energy by themselves. Before the workshop, participants interviewed tended to believe that energy production and supply were an industrial and professional practices which ordinary people could not be involved in themselves. After building the solar PV products, however, they started recognising the possibility of having a personally-owned, solar products and that it was important to use renewable energy products to maintain their everyday life. In the end, they were no longer merely customers, but they had been transformed into energy producers and makers.

The other conclusion to be drawn from the interviews is that some participants remained hesitant to partake in community-led renewable energy initiatives even though they had enjoyed the interactions with each other. Workshops were successful in increasing interactions among participants by sharing tools and cooperating with each other to create a friendly and warm atmosphere. When interviewees were given a scaled question of willingness of partici-

pation in renewable energy that was governed by community, all of them also reported positive responses. Actually, one of the participants of the SWDs became an organizer of following workshops by inviting us to share the production experience with his colleagues. Nevertheless, in the open-ended questions which asked for the reasons of their choices, half of interviewees who chose a very high level of willingness to be part of community-led renewable energy initiatives also showed a certain degree of skepticism. According to interview data, their hesitation resulted from a lack of information on and unfamiliarity with the community-managed renewable energy resources.

Interestingly, there was little change in a strong belief that the government bore the primary responsibility for renewable energy transition. The importance of the role of community and people in renewable energy transition increased, but the interviewees still strongly believed that the government should take a bigger responsibility than the market, community and people for renewable energy transition.

06.

Discussion

After reporting the interview findings, this chapter provides further discussion which consists of evaluation of the research questions, limitations and a possible topic for further study.

6.1 Evaluation of Research Questions

The SWD was designed to encourage the workshop participants to recognize renewable energy as a common pool resource. Comprehension of this concept is essential to reshape human-energy relations towards more active, interactive and diverse possibilities. Understanding this concept will eventually increase the social acceptance of renewable energy. Overall, six SWDs took places in different locations across Finland and action research and semi-structured interviews were conducted to analyse the positive impact of SDWs on consumer comprehension of renewable energy because of participation in such workshops.

The first conclusion is that SDWs considerably influenced participants to have positive attitudes toward the solar PV technology and to become involved in self-sufficient, renewable energy production. Particularly, the uncomplicated procedure of assembling solar PV products and testing the solar PV products under the sun were the most successful part of SDWS that contributed positively to impact participant attitude towards solar PV technologies. Experiencing the undemanding procedures helped participants to become more confident in assembling the solar PV products and to recognize the possibilities of personally owning solar products. Testing the products they built that produced electricity seemed to cause participants to appreciate the importance of renewable energy in maintaining their everyday life. This result has shown that DIY activity with renewable energy can be a “critical” activity (Ratto 2014) which can have transformative power to impact practitioner’s understanding about the technologies they built.

Furthermore, this study indicates that having a DIY activity effectively empowers participants to upgrade their consumer roles from mere customer or passive end-users to recognizing that they are empowered, ordinary people who can organize renewable energy use on their own. In the conventional renewable energy regime, users mainly act on a ‘plug-and-forget’ basis and renewable energy is mainly perceived as commodity. Most decisions regarding renewable energy production and supply are made by governments or energy providers. However, in the empowered approach to renewable energy, different practices and relationships with the energy are required. In SDWs, participants recognize that energy is something they can organize themselves. They are enabled to perform as energy producers and makers without professional intervention. The relationship between users and renewable energy, therefore, has been transformed into more active and interactive one.

More notably, having a DIY activity also allowed the participants the opportunity to consider the conventional renewable energy system and increased the possibility of making changes to that system. During the SDWs, the participant interest greatly increased. That interest included not only advantages, but also disadvantages of having renewable energy. However, it seems that recognizing the drawbacks of renewable energy did not discourage people from participating in self-sufficient energy production activity, but rath-

er gave them a chance to understand the current renewable energy development in a balanced perspective. After SDWs, many participants recognized their ignorance regarding renewable energy in the past and the importance of future use of the technologies to maintain their everyday lifestyles in the long-term. Willingness to power their homes with renewable energy and to adopt additional change in energy usage behavior also measurably increased.

In this regard, these findings support the argument that people can act as politically and socially empowered actors, regarding renewable energy and actively engage with energy in diverse ways to achieve low-carbon energy transitions. Passive end-users and self-centered customers has been a dominating perspective in research on public response to renewable energy. However, recent studies have begun to recognize the importance of extended potential of users in participatory engagement with energy, referred to as "energy citizenship in the low-carbon energy transitions" (Ryghaug et al. 2018; Paulos and Pierce 2011). Energy prosumer's activities for example, such as washing clothes or dishes while the sun is shining to decrease dependence on centralized electricity production can be seen as one such participatory engagement with renewable energy. (Christensen et al. 2017) SDWs also provides another opportunity for a self-building activity, in the form of workshop, can be a way to engage people with renewable energy and cultivate the energy citizenship.

Approaching renewable energy as a common pool resource implies not only personal involvement but also collective participation in renewable energy transition. The SDWs were successful to increase interactions among participants by sharing tools and to cooperating each other and willingness to be part of community-led renewable energy initiatives. Some of the participants became more open to their neighbours. One participants of the SWDs even became an organizer of future workshops to share the production experience with colleagues.

The perceptual transformation, expanded role of users and positive influecen about collective action are also applicable to professionals. The SDW was designed mainly for the layperson of renewable energy. However, professionals involved in SDWs also revealed that they also had limited opportunities to engage in hands-on experiences with renewable energy. They too enjoyed assembling solar PV products in the same manner as did the ordinary people involved in SDWs. Until now, most research exploring professional recommendations to promote community-led renewable energy have assumed that professionals have more experiences and knowledge about renewable energy than ordinary people. (Ruggiero et al. 2015; Aukeala 2017) However, this study indicates that some professionals actually had minimal hands-on experience with renewable energy. They also reported positive impressions of participating in uncomplicated procedures when assembling solar PV products. They, in turn, became increasingly more positive about the community-led renewable energy.

Nevertheless, inconsistency in public attitude to community-led renewable energies has been also revealed though this study. While participants significantly became more positive towards the community-led renewable energy in scale questions, with the open-ended questions to determine the reasons of their choices, there was still a certain level of scepticism about collective action in managing renewable energy that remained. According to the interviewees, this hesitation resulted from a lack of information or unfamiliarity with the governing the renewable energy in collective manner.

The other explanation is that this hesitation resulted from the strong belief that it was the government which was responsible to oversee renewable energy transition. In the light nature of CPRs, as illustrated in the literature review, the strong dependence on governments accelerated the commodification of renewable energy and prevented people from recognizing the collective action. The dis-embedded process of renewable energy from society shapes the relationship between human being and renewable energy as being distant, deliberated and one-way. Actually, some of interviewees still argued for strong state control as producers and suppliers because of people's selfishness. Unfortunately, the data collected in this thesis was insufficient to prove that there is a correlation between intense belief in national efforts and public non-participation in renewable energy transition.

The last sub-question of this thesis was on effectiveness of SDWs as support mechanism for solar energy distribution. Sten (2014) notes that in current energy policy studies, prices and income restraints are seen as the main drivers of individual and household choices regarding energy use. His argument supports current energy policies are largely dominated by economic instruments (Roelich and Knoeri 2015): e.g., regulatory and pricing policies such as feed-in tariffs (FiTs) and tax incentives; public finance and fiscal incentives to renewable industry; and public-private partnership (PPPs). Finland has also actively established tax incentives to promote renewable energy (Jung et al 2016).

Strong financial incentives can be beneficial in increasing overall rate of adaptation of renewable energy technologies. However, these approaches also have limitations of their support mechanisms to distribute the renewable energy at the community level. First of all, the financial aspect is one of determinants of energy selection for households. Sten (2014) explains that energy selections are affected by diverse factors and financial incentive is just one of those. Also financial incentive is more likely to accelerate the marketization of renewable energy by appealing to private companies or individuals seeking after profits rather than the benefit of ordinary people. This approach may significantly prioritize the financial value of renewable energy over environmental and social ones.

Contrary to the regulatory and pricing policies, however, the SDWs have different advantages as effective and creative support mechanisms to increase the social acceptance of renewable energy at individual and community levels. SDWs empower individuals to play diverse roles – energy makers, producer and organizers of SDWs – regarding renewable energy and open the possibility for collective action in governing of renewable energy. Notably, the SDWs effectively increase participants' motivation to be part of self-sufficient, renewable energy production. One of the responses found that the participants of SDWs showed higher motivation to be involved in the workshop, compared to other workshops she had previously been involved in. This is it's greatest strength as support mechanism to distribute the renewable energy at an individual level, compared to a typical from of workshops.

This thesis has been argued for the importance of grassroots-level, in particular self-governing institutions, in governing renewable energy effectively. However, underlying argument of thesis is not to argue if the centralization and privatization of renewable energy should be entirely replaced by grassroots-level actions for mitigating CO2 emission or if the SDWs is the most efficient way to increase the public acceptance of renewable energy. Instead, multi-level governance is required since the increase CO2 emission cannot be solved with merely one approach (Hoogma et al. 2002; Seyfang et al. 2013; Ostrom 2010b). Thus, the SDWs can act as an important part of multi-level solutions for mitigating man-made CO2 emission.

Consequently, this study proves that SDWs has a transformative power to stimulate participants to have positive attitudes toward the solar PV technology and to become involved in self-sufficient, renewable energy production. By having self-building activity with renewable energy, the participants play different roles - energy makers, providers and organizers of SDWs. The setting of SDWs was also effective to increase the interaction among participants by cooperating together and sharing tools. However, the building solar PV products with other participants would be insufficient to eliminate completely the hesitations regarding participation in community governance of renewable energy. Despite of this limitation, however, this study proves that SDWs has different advantages as support mechanism to promote the renewable energy at individual and community levels.

6.2 Limitation of Research

This thesis achieves its goal of assessing the influence of workshop based self-building activity to encourage participants to recognize renewable energy as a CPR. However, there are also several limitations of this research. First of all, the SDW is quantitatively limited in application. Every workshop had, on average, twenty participants which is too small-scale to distribute renewable energy use effectively. Considering that increase man-made CO2 is an urgent problem which needs to be addressed as soon as possible, SDWs would be ineffective to the scale of effectiveness required to produce results in a timely manner. Therefore, there is a need to find a new way to reach to larger numbers of people who are interested in having self-building activity with renewable energy.

Second is that the research findings do not consider cultural influences in understanding renewable energy. The majority of the participants of SDWs was Finnish. Nine out of fifteen interviewees were also Finnish. As already mentioned, one of crucial actors to shape social acceptance is participants types. The research findings could also be different when considering cultural differences in shaping public response to renewable energy. However, it is, to a certain extent, impossible to contain cultural influence in public acceptance of renewable energy in Finland because this country is an international society with a 20 percentage rate of a foreign population.

Another limitation of this thesis is that its study format was difficult to determine the long-term, post-workshop effects. The post- workshop interview with participants took place directly after involvement in self-sufficient, renewable energy production and focused on change in participant understanding of solar energy. It allowed researchers to capture only immediate changes. The perceptual change of participants, which may have happened while using the solar PV products on a daily basis, was unable to be determined in this thesis. Studying online communication also shares the same problem. One of the tasks of SDWs was to increase interactions among participants; online communication was one of the methods involved. Unfortunately, since the third workshop, no one shared results on social media, for some reason. Why this happened after freely providing these materials was undetermined during the post workshop interviews due to time constraints.

Despite of these limitations, it could be said that this thesis significantly contributes to discussion on social acceptance of renewable energy by shifting a focus from influence of external actors to internal dynamics of social acceptance of renewable energy. In addition, research on social acceptance does not adequately address the need of new models of participation in renewable energy transition. The results of Solar DIY Workshops proves that alternative ways of public engagement is helpful to increase social acceptance of renewable energy at the local level.

6.3 Further Research

Research on social acceptance of renewable energy has been conducted for several decades with new topics regarding this issue. However, in reviewing literature for this thesis and conducting SDWs, several further research topics on social acceptance of renewable energy could be proposed. Firstly, more research needs to be focused on creating alternative ways of public involvement in renewable energy transition. As noted above, less academic attention has given to diversifying ways of engaging in the energy transition (Ryghaug et al. 2018; Clausen 2016) and even existing ways are considerably limited to a few exercises, e.g., structured workshops or official activities led by external consultants - like regional governments - and by consumer research led by universities (Ryghaug et al 2018). However, in order to increase the social acceptance at individual and community levels, much more diverse and different means of engagement should be suggested; by these means, it would encourage a much more diverse group of people in the community to be part of the renewable energy transition. However, creating new models of participation should not remain as merely "fine-tuning techniques" because, in many cases, involving a different methodological tools will not likely change the disinterest of citizens in participation (Clusen 2016). Structural changes of participation, as well as creating consensus among actors, should be also considered in constructing different models of participation.

Second, as this study indicates, the hesitation to become involved in community-led renewable energy is derived from a lack of information and unfamiliarity with this subject. Further research needs to explore providing information and increasing familiarity with community-led renewable energy. According to Geraint and Gianluca (2016), the familiarity with renewable energy is one of key issues in shaping public response of community-led, renewable energy initiatives. Wolsink (2007) shows that the public attitude to renewable energy technologies which was negative in the beginning of implementation can be changed positively after experiencing renewable energy. However, those research studies only address the importance of familiarity with the technologies but not mentions how to increase the familiarity. Therefore, further discussion needs to deal with how to increase the familiarity with the community-led renewable energy and how to provide indirect experiences of governing renewable energy in collective manners.

Also, the correlation between an intense belief in national responsibility and public non-participation in renewable energy transition should be addressed as further research topic as well. As mentioned above, the data collected in this thesis is insufficient to prove the association. However, according to Ostrom (1990), there is a close relationship between the strong control by states and the degradation of collective powers. The research exploring this relationship would provide a new insight into how and in which way collective action could occur as well as indicating what barriers which hinder renewable energy initiatives by citizens.

07.

Conclusion

The importance of renewable energy development at the local level has been growingly recognized due to a rapid increase of human-driven CO2. However, public resistance to renewable energy change has frequently formed in many places. This thesis defines that the current renewable energy regime exists and is largely driven by states and markets. The relationship between human and energy in this regime appears to be deliberated, separated and one-way. In order to reshape the human-energy relations towards more interactive, democratic and diverse options, this thesis proposes a Solar DIY Workshop, intended to encourage its participants to perceive that renewable energy is a collective, grassroots initiative by providing a self-building activity with renewable energy.

Overall, six Solar DIY workshops were held in different locations across Finland. Through action research and semi-structured interviews, this thesis draws a clear conclusion that understanding renewable energy as a CPR is effectively achievable by workshop based, self-building activity. Self-building activity considerably enabled participants to form positive attitudes toward the solar PV technology and to seek involvement in self-sufficient renewable energy production. Having a DIY activity effectively empowered participants to perform as active and affected actors regarding renewable energy, e.g., to act as energy producers, makers and organisers of the DIY workshop rather than acting merely as customers. Additionally, it was successful to increase interactions among participants by sharing tools and cooperating with each other to create a friendly and warm atmosphere in the workshops. However, building solar PV products with other participants would be insufficient to completely eliminate hesitations regarding involvement in community governing of renewable energy. In order to eliminate hesitation and eventually increase social acceptance of renewable energy at the community level, further research should focus on: how to increase the familiarity of community-led renewable energy and a correlation between intense belief in national responsibility and public non-participation in the renewable energy transition. Thus, this thesis has proved the effectiveness of the Solar DIY workshop as support mechanism for solar energy distribution as well as a means to increase willingness of consumers to involve in self-sufficient energy production and to be part of community-led renewable energy initiatives.

References

Aukeala, Anu. 2017. "FROM MARGINAL TO MAINSTREAM Challenges of Citizen-Led Renewable Energy Initiatives in Finland." Master thesis, Jyväskylä: Jyväskylä University School of Business and Economics.

Atkinson, P. 2006. "Do It Yourself: Democracy and Design." Journal of Design History 19 (1): 1–10. https://doi.org/10.1093/jdh/epk001.

Aitken, Mhairi. 2010. "Why We Still Don't Understand the Social Aspects of Wind Power: A Critique of Key Assumptions within the Literature." Energy Policy, Energy Security - Concepts and Indicators with regular papers, 38 (4): 1834–41. https://doi.org/10.1016/j.enpol.2009.11.060.

Ashdenasward. 2011. "Case Study Summary Transition Together, Transition Town Totnes, Devon, UK." The Ashden Awards for sustainable energy.

Barnett, Julie, Kate Burningham, Gordon Walker, and Noel Cass. 2012. "Imagined Publics and Engagement around Renewable Energy Technologies in the UK." Public Understanding of Science 21 (1): 36–50. https://doi.org/10.1177/0963662510365663.

Basu, Soutrik, Joost Jongerden, and Guido Ruivenkamp. 2017. "The Emergence of a Hybrid Mode of Knowledge Production in the Generation Challenge Programme Rice Research Network (GCP-RRN) in India: Exploring the Concept of Commons-Based Peer Production (CBPP)." Geoforum 84 (August): 107–16. https://doi.org/10.1016/j.geoforum.2017.06.008.

Batel, Susana, and Patrick Devine-Wright. 2015. "Towards a Better Understanding of People's Responses to Renewable Energy Technologies: Insights from Social Representations Theory." Public Understanding of Science 24 (3): 311–25. https://doi.org/10.1177/0963662513514165.

Barnes, Peter. 2006. Capitalism 3.0: A Guide to Reclaiming the Commons. 1st ed. A BK Currents Book. San Francisco : Berkeley: Berrett-Koehler ; U.S. trade bookstores and wholesalers, Publishers Group West.

Braun, Virginia, and Victoria Clarke. 2006. "Using Thematic Analysis in Psychology." Qualitative Research in Psychology 3 (2): 77–101. https://doi.org/10.1191/1478088706qp063oa.

Beagle, Donald. 1999. "Conceptualizing an Information Commons." The Journal of Academic Librarianship 25 (2): 82–89. https://doi.org/10.1016/S0099-1333(99)80003-2.

Becker, Sören, and Conrad Kunze. 2014. "Transcending Community Energy: Collective and Politically Motivated Projects in Renewable Energy (CPE) across Europe." People, Place and Policy Online 8 (3): 180–91. https://doi.org/10.3351/ppp.0008.0003.0004.

Bollier, David. 2007. "A New Politics of the Commons." Renewal, December 17, 2007.

Boone, Harry N, and Deborah A Boone. 2012. "Analyzing Likert Data." Journal of Extension 50–2: 5.

Bertsch, Valentin, Margeret Hall, Christof Weinhardt, and Wolf Fichtner. 2016. "Public Acceptance and Preferences Related to Renewable Energy and Grid Expansion Policy: Empirical Insights for Germany." Energy 114 (November): 465–77. https://doi.org/10.1016/j.energy.2016.08.022.

Byrne, John, Aiming Zhou, Bo Shen, and Kristen Hughes. 2007. "Evaluating the Potential of Small-Scale Renewable Energy Options to Meet Rural Livelihoods Needs: A GIS- and Lifecycle Cost-Based Assessment of Western China's Options." Energy Policy 35 (8): 4391–4401. https://doi.org/10.1016/j.enpol.2007.02.022.

Byrne, John, Cecilia Martinez, and Colin Ruggero. 2009. "Relocating Energy in the Social Commons: Ideas for a Sustainable Energy Utility." Bulletin of Science, Technology & Society 29 (2): 81–94. https://doi.org/10.1177/0270467609332315.

Chilvers, Jason, and Mattew Kearnes. 2016. Remaking Participantion: Science, Environment and Emergent Publics. London.

Chilvers, Jason, and Noel Longhurst. 2016. "Participation in Transition(s): Reconceiving Public Engagements in Energy Transitions as Co-Produced, Emergent and Diverse." Journal of Environmental Policy & Planning 18 (5): 585–607. https://doi.org/10.1080/1523908X.2015.1110483

Clausen, Laura Tolnov. 2016. "Re-Inventing the Commons." In Commons, Sustainability, Decmocratization: Action Research and the Basic Renewable of Society, 29.

Clausen, Laura Tolnov. 2017. "No Interest in Landscape? The Art of Non-Participation in Danish Landscape Planning." Landscape Research 42 (4): 412–23. https://doi.org/10.1080/01426397.2016.1206870.

Clean Energy Regulator. n.d. "Increase in Large-Scale Renewable Energy Power Station Capacity and Generation." Accessed February 19, 2019. http://www.cleanenergyregulator.gov.au/About/Pages/Accountability%20and%20reporting/Administrative%20Reports/The%20Renewable%20Energy%20Target%202016%20Administrative%20Report/Increase-in-large-scale-renewable-energy-power-station-capacity-and-generation.aspx.

Coyne, Richard. 2005. "Wicked Problems Revisited." Design Studies 26 (1): 5–17. https://doi.org/10.1016/j.destud.2004.06.005.

Desouza, Kevin C. 2008. "Understanding Knowledge as a Commons: From Theory to Practice." Journal of the American Society for Information Science and Technology 59 (2): 333–34. https://doi.org/10.1002/asi.20747.

Devine-Wright, Patrick. 2005. "Beyond NIMBYism: Towards an Integrated Framework for Understanding Public Perceptions of Wind Energy." Wind Energy 8 (2): 125–39. https://doi.org/10.1002/we.124.

Devine Wright, Patrick. 2009. "Rethinking NIMBYism: The Role of Place Attachment and Place Identity in Explaining Place-Protective Action." Journal of Community & Applied Social Psychology 19 (6): 426–41. https://doi.org/10.1002/casp.1004.

Devine-Wright, Patrick, Susana Batel, Oystein Aas, Benjamin Sovacool, Michael Carnegie Labelle, and Audun Ruud. 2017. "A Conceptual Framework for Understanding the Social Acceptance of Energy Infrastructure: Insights from Energy Storage." Energy Policy 107 (August): 27–31. https://doi.org/10.1016/j.enpol.2017.04.020.

Devine-Wright, Patrick. 2011. "Place Attachment and Public Acceptance of Renewable Energy: A Tidal Energy Case Study." Journal of Environmental Psychology 31 (4): 336–43. https://doi.org/10.1016/j.jenvp.2011.07.001.

Devine-Wright, Patrick, ed. 2007. "Energy Citizenship: Psychological Aspects of Evolution in Sustainabl Energy Technology." In Governing Technology for Sustainability. London; Sterling, VA: Earthscan.

Dietz, Thomas, Elinor Ostrom, and Paul C Stern. 2003. "The Struggle to Govern the Commons." Science 302: 6.

E. Moula, Md. Munjur, Johanna Maula, Mohamed Hamdy, Tingting Fang, Nusrat Jung, and Risto Lahdelma. 2013. "Researching Social Acceptability of Renewable Energy Technologies in Finland." International Journal of Sustainable Built Environment 2 (1): 89–98. https://doi.org/10.1016/j.ijsbe.2013.10.001.

Ebbesen, Toke Riis. 2017. "Little Sun: An Indicative Framework for the Analysis of Art and Design Objects." Design Issues 33 (1): 48–60. https://doi.org/10.1162/DESI_a_00425.

Eurostat. 2019. "Renewable Energy in the EU: Share of Renewable Energy in the EU up to 17.5% in 2017." Newsrelease. Eurost. https://ec.europa.eu/eurostat/documents/2995521/9571695/8-12022019-AP-EN.pdf/b7d237c1-ccea-4adc-a0ba-45e13602b428.

European Commission. 2007. "Energy Technologies: Knowledge, Perception, Measures." http://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_262_en.pdf.

Geels, Frank W., and Johan Schot. 2007. "Typology of Sociotechnical Transition Pathways." Research Policy 36 (3): 399–417. https://doi.org/10.1016/j.respol.2007.01.003.

Geraint, Ellis, and Ferraro Gianluca. 2016. "The Social Acceptance of Wind Energy." EUR 28182 EN. doi 10.2789/696070. https://ec.europa.eu/jrc.

Greenwood, Davydd, and Morten Levin. 2001. "Pragmatic Action Research and the Struggle to Transform Unidversities into Learning Communities." In Handbook of Action Research: Participative Inquiry and Practice, 103. SAGE.

Goldthau, Andreas. 2014. "Rethinking the Governance of Energy Infrastructure: Scale, Decentralization and Polycentrism." Energy Research & Social Science 1 (March): 134–40. https://doi.org/10.1016/j.erss.2014.02.009.

Guest, Greg, Kathleen M. MacQueen, and Emily E. Namey. 2011. Applied Thematic Analysis. SAGE Publications.

Hardin, Garrett. 1968. "The Tragedy of the Commons" 162: 7.

Haggett, Claire. 2011. "Understanding Public Responses to Offshore Wind Power." Energy Policy 39 (2): 503–10. https://doi.org/10.1016/j.enpol.2010.10.014.

Hall, N., P. Ashworth, and P. Devine-Wright. 2013. "Societal Acceptance of Wind Farms: Analysis of Four Common Themes across Australian Case Studies." Energy Policy 58 (July): 200–208. https://doi.org/10.1016/j.enpol.2013.03.009.

Hopkins, Rob. n.d. "Transition Culture." Accessed January 12, 2019. https://www.transitionculture.org/.

Hoogma, Remco, Rene Kemp, Johan Schot, and Bernhard Truffer. 2002. Experimenting for Sustainable Transport: The Approach of Strategic Niche Management. London, UNITED KINGDOM: Routledge. http://ebookcentral.proquest.com/lib/aalto-ebooks/detail.action?docID=240574.

Hu, Jing, Robert Harmsen, Wina Crijns-Graus, Ernst Worrell, and Machteld van den Broek. 2018. "Dentifying Barriers to Large-Scale Integration of Variable Renewable Electricity into the Electricity Market_ A Literature Review of Market Design" 81 (Renewable and Sustainable Energy Reviews): 2181–95. https://doi.org/10.1016/j.rser.2017.06.028.

Huttunen, Riku. 2017. "Government Report on the National Energy and Climate Strategy for 2030 (Unofficial Translation)." Helsinki: Finnish Ministry of Economic Affairs and Employment. http://urn.fi/URN:ISBN:978-952-327-199-9.

Hyysalo, Sampsa, Jouni K. Juntunen, and Stephanie Freeman. 2013. "User Innovation in Sustainable Home Energy Technologies." Energy Policy 55 (April): 490–500. https://doi.org/10.1016/j.enpol.2012.12.038.

Intergovernmental Panel on Climate Change (IPCC), ed. 2014. Climate Change 2014: Synthesis Report. Geneva, Switzerland: Intergovernmental Panel on Climate Change.

Jalas, Mikko, Helka Kuusi, and Eva Heiskanen. 2014. "Self-Building Courses of Solar Heat Collectors as Sources of Consumer Empowerment and Local Embedding of Sustainable Energy Technology." Technology Studies, 21.
Julian, Caroline. 2014. "Creating Local Energy Economies: Lessons from Germany." ResPublica.

Jung, Nusrat, Munjur E. Moula, Tingting Fang, Mohamed Hamdy, and Risto Lahdelma. 2016. "Social Acceptance of Renewable Energy Technologies for Buildings in the Helsinki Metropolitan Area of Finland." Renewable Energy 99 (December): 813–24. https://doi.org/10.1016/j.renene.2016.07.006.

Karlstrøm, Henrik, and Marianne Ryghaug. 2014. "Public Attitudes towards Renewable Energy Technologies in Norway. The Role of Party Preferences." Energy Policy 67 (April): 656–63. https://doi.org/10.1016/j.enpol.2013.11.049.

Kemmis, Stephen. 2009. "Action Research as a Practice based Practice." Educational Action Research 17 (3): 463–74. https://doi.org/10.1080/09650790903093284.

Kuznetsov, Stacey, and Eric Paulos. 2010. "Rise of the Expert Amateur: DIY Projects, Communities, and Cultures." In Proceedings of the 6th Nordic Conference on Human-Computer Interaction Extending Boundaries - NordiCHI '10, 295. Reykjavik, Iceland: ACM Press. https://doi.org/10.1145/1868914.1868950.

Künneke, Rolf. 2009. "The Governance of Infrastructures as Common Pool Resources." In . Bloomington.

Laerhoven, Frank van, and Elinor Ostrom. 2007. "Traditions and Trends in the Study of the Commons." International Journal of the Commons 1 (1): 3–28. https://doi.org/10.18352/ijc.76.

Latour, B. 2005. Making Things Public: Atmospheres of Democracy. Cambridge: MIT Press.

Lawhon, Mary, and James T. Murphy. 2011. "Socio-Technical Regimes and Sustainability Transitions: Insights from Political Ecology." Progress in Human Geography 36 (3): 354–78.

Lee, Yunjin. 2016. "The Niche strategy of Civilian-led Energy Self-sufficient Village for the Energy Transition - the case of Sungdaegol Village in Seoul." Doctoral dissertation. The graduate School of Environmental Studies, Seoul National University.

Lewin, Kurt. 1946. "Action Research and Minority Problems," no. Journal of social issues. https://doi.org/10.1111/j.1540-4560.1946.tb02295.x.

Linebaugh, Peter. 2014. Stop, Thief! The Commons, Enclosures and Resistance. Oakland: PM Press.

"Little Sun." n.d. Accessed January 18, 2019. https://littlesun.com/.

Nair, Nirmal-Kumar C., and Niraj Garimella. 2010. "Battery Energy Storage Systems: Assessment for Small-Scale Renewable Energy Integration." Energy and Buildings 42 (11): 2124–30. https://doi.org/10.1016/j.enbuild.2010.07.002.

NAZCA. 2018. n.d. Accessed January 23, 2019. http://climateaction.unfccc.int/.

Miller, Clark A., Alastair Iles, and Christopher F. Jones. 2013. "The Social Dimensions of Energy Transitions." Science as Culture 22 (2): 135–48. https://doi.org/10.1080/09505431.2013.786989.

Morradi, Soroush, and Goeun Park. 2017. "Final Report, Solar PET: Solar Panel DIY Workshop." Aalto University, Creative Sustainability, Personal project.

Ogilvie, Matthew, and Christopher Rootes. 2015. "The Impact of Local Campaigns against Wind Energy Developments." Environmental Politics 24 (6): 874–93. https://doi.org/10.1080/09644016.2015.1063301.

Ostrom, Elinor. 1990. Governing the Commons - the Evolutioin and Institutions for Collective Action. Cambridge: Cambridge University Press.

Ostrom, Elinor and Walker James. 1997. "Neither Markets nor States: Linking Transformation Process in Collective Action Arenas." In Perspectives on Public Choice: A Hand Book, 35–72. Cambridge University Press.

Ostrom, Elinor. 2010a. "Beyond Markets and States: Polycentric Governance of Complex Economic Systems." American Economic Review 100 (3): 641–72. https://doi.org/10.1257/aer.100.3.641.

Ostrom, Elinor. 2010b. "A Long Polycentric Journey." Annual Review of Political Science 13 (1): 1–23. https://doi.org/10.1146/annurev.polisci.090808.123259.

Paulos, E., and J. Pierce. 2011. "Citizen Energy: Towards Populist Interactive Micro-Energy Production." In 2011 44th Hawaii International Conference on System Sciences, 1–10. https://doi.org/10.1109/HICSS.2011.99.

Perovich, Laura J. 2018. "Environmental Art: A Path to Civic Progress in a Time of Policy Retreat in the United States." Edited by Gustavo Cunha Araújo. Cogent Arts & Humanities 5 (1): 1–18. https://doi.org/10.1080/23311983.2018.1523269.

Pidgeon, N., C. Demski, C. Butler, K. Parkhill, and A. Spence. 2014. "Creating a National Citizen Engagement Process for Energy Policy." Proceedings of the National Academy of Sciences 111 (Supplement_4): 13606–13. https://doi.org/10.1073/pnas.1317512111.

Polanyi, Karl. [1944]2001. The Great Transformation: The Political and Economic Origins of Our Time. Boston: Beacon Press.

Rapoport, Robert N. 1970. "Three Dilemmas in Action Research: With Special Referecen to the Tavistock Experience." Human Relations 23 (6): 499–513.

REN21. 2017. "Renewables 2017: Global Status Report." http://proxy.library.carleton.ca/loginurl=https://www.deslibris.ca/ID/10091341.

Ruostetsaari, Ilkka. 2009. "Governance and Political Consumerism in Finnish Energy Policy-Making." Energy Policy 37 (1): 102–10. https://doi.org/10.1016/j.enpol.2008.08.001.

Ratto, Matt. 2011. "Critical Making: Conceptual and Material Studies in Technology and Social Life." The Information Society 27 (4): 252–60. https://doi.org/10.1080/01972243.2011.583819.

Ratto, Matt, and Megan Boler. 2014. DIY Citizenship: Critical Making and Social Media. Cambridge, UNITED STATES: MIT Press. http://ebookcentral.proquest.com/lib/aalto-ebooks/detail.action?docID=3339737.

Riel, Margaret. 2017. "Understanding Action Research." 2017. http://cadres.pepperdine.edu/ccar/define.html.

Rocha, Maria, Fabio Sferra, Michiel Schaeffer, Niklas Roming, Andrzej Ancygier, Paola Parra, Jasmin Cantzler, Alain Coimbra, and Bill Hare. 2016. "What Does the Paris Climate Agreement Mean for Finland and the European Union?" Berline: Climage Analytics. https://climateanalytics.org/media/ca_paris_agreement_finland_eu.pdf.

Roelich, Katy, and Knoeri Christof. 2015. "Governing the Infrastructure Commons: Lessons for Community Energy from Common Pool Resource Management." Sustainability Research Institute (SRI), School of Earth and Environment, The University of Leeds.

Roelich, Katy, Christof Knoeri, Julia K. Steinberger, Liz Varga, Phil T. Blythe, David Butler, Rajat Gupta, Gareth P. Harrison, Chris Martin, and Phil Purnell. 2015. "Towards Resource-Efficient and Service-Oriented Integrated Infrastructure Operation." Technological Forecasting and Social Change 92 (March): 40–52. https://doi.org/10.1016/j.techfore.2014.11.008.

Reason, Peter, and Hilary Bradbury, eds. 2008. Handbook of Action Research: Participative Inquiry and Practice. 2nd ed. London ; Thousand Oaks, Calif: SAGE Publications.

Ruggiero, Salvatore, Vilja Varho, and Pasi Rikkonen. 2015. "Transition to Distributed Energy Generation in Finland: Prospects and Barriers." Energy Policy 86 (November): 433–43. https://doi.org/10.1016/j.enpol.2015.07.024.

Ryghaug, Marianne, Tomas Moe Skjølsvold, and Sara Heidenreich. 2018. "Creating Energy Citizenship through Material Participation." Social Studies of Science 48 (2): 283–303. https://doi.org/10.1177/0306312718770286.

Schoor, Tineke van der, and Bert Scholtens. 2015. "Power to the People: Local Community Initiatives and the Transition to Sustainable Energy." Renewable and Sustainable Energy Reviews 43 (March): 666–75. https://doi.org/10.1016/j.rser.2014.10.089.

Seyfang, Gill, Jung Jin Park, and Adrian Smith. 2013. "A Thousand Flowers Blooming? An Examination of Community Energy in the UK." Energy Policy 61 (October): 977–89. https://doi.org/10.1016/j.enpol.2013.06.030.

"Solar DIY Workshop Website." n.d. Hide Design. Accessed April 11, 2019. http://www.hidedesign.co/blog.

Simoniti, Vid. 2018. "Assessing Socially Engaged Art." The Journal of Aesthetics and Art Criticism 76 (1): 71–82. https://doi.org/10.1111/jaac.12414.

Silverman, David. 2005. Doing Qualitative Research: A Practical Handbook. SAGE Publications.

Shiva, Vandana. 2018. Earth Democracy: Justice, Sustainability and Peace. London: Zed Books.

Sovacool, Benjamin K. 2009. "Rejecting Renewables: The Socio-Technical Impediments to Renewable Electricity in the United States." Energy Policy 37 (11): 4500–4513. https://doi.org/10.1016/j.enpol.2009.05.073.

Sovacool, Benjamin K. 2014. "Energy Studies Need Social Science." Nature, 2014.

Sparke, Penny. 1995. As Long It's Pink : The Sexual Politics of Taste. Pandora.

Sten, Paul C. 2014. "Individual and Household Interactions with Energy Systems: Toward Integrated Understanding." Energy Research & Social Science, no. 1: 41–48.

"성대골사람들" n.d.성대골사람들. Accessed January 12, 2019. http://sdgpeople.or.kr/.

"Transition Town Totnes - Taking Positive Action Together in a Changing World." n.d. Accessed January 11, 2019. https://www.transitiontowntotnes.org/.

Tanenbaum, Joshua G., Amanda M. Williams, Audrey Desjardins, and Karen Tanenbaum. 2013. "Democratizing Technology: Pleasure, Utility and Expressiveness in DIY and Maker Practice." In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13, 2603. Paris, France: ACM Press. https://doi.org/10.1145/2470654.2481360.

United Nations, 2016. The Sustainable Development Goals Report 2016, United Nations, New York.

Vandenbergh, Michael P, Paul C Stern, Gerald T Gardner, Thomas Dietz, and Jonathan M Gilligan. 2010. "Implementing the Behavioral Wedge: Designing and Adopting Effective Carbon Emissions Reduction Programs." Environmental Law Institute, 9.

Venkataramanan, Giri, and Chris Marnay. 2008. "A Larger Role for Microgrids." IEEE Power and Energy Magazine 6 (3): 78–82. https://doi.org/10.1109/MPE.2008.918720.

Walker, Gordon, and Patrick Devine-Wright. 2008. "Community Renewable Energy: What Should It Mean?" Energy Policy 36 (2): 497–500. https://doi.org/10.1016/j.enpol.2007.10.019.

Walker, Gordon, Patrick Devine-Wright, Sue Hunter, Helen High, and Bob Evans. 2010. "Trust and Community: Exploring the Meanings, Contexts and Dynamics of Community Renewable Energy." Energy Policy 38 (6): 2655–63. https://doi.org/10.1016/j.enpol.2009.05.055.

Whitmarsh, Lorraine E, Paul Upham, Wouter Poortinga, Carly MacLachlan, Andrew Darnton, Fionnguala Sherry-Brennan, Patrick Devine-Wright, and Christina C Demski. 2011. "Public Attitudes, Understanding, and Engagement in Relation to Low-Carbon Energy. A Selective Review of Academic and Non-Academic Liter-

atures : Report for RCUK Energy Programme,'' report for RCUK Energy Programme., , no. Research Councils UK. http://orca.cf.ac.uk/22753/.

Wittmayer, Julia, Niko Schäpke, Georg Feiner, Ralph Piotrowski, Frank van Steenbergen, and Stefanie Baasch. 2013. ''Action Research for Sustainability Reflections on Transition Management in Practice.'' Ecologic Institute. https://incontext-fp7.eu/sites/default/files/InContext-ResearchBrief-Action_research_for_sustainability.pdf.

Wolsink, Maarten. 2007. ''Planning of Renewables Schemes: Deliberative and Fair Decision-Making on Landscape Issues Instead of Reproachful Accusations of Non-Cooperation.'' Energy Policy 35 (5): 2692–2704. https://doi.org/10.1016/j.enpol.2006.12.002.

Wolsink, Maarten. 2012a. ''The Research Agenda on Social Acceptance of Distributed Generation in Smart Grids: Renewable as Common Pool Resources.'' Renewable and Sustainable Energy Reviews 16 (1): 822–35. https://doi.org/10.1016/j.rser.2011.09.006.

Wolsink, Maarten. 2012b. ''Undesired Reinforcement of Harmful 'Self-Evident Truths' Concerning the Implementation of Wind Power.'' Energy Policy 48 (September): 83–87. https://doi.org/10.1016/j.enpol.2012.06.010.

Wolsink, Maarten. 2013. ''Fair Distribution of Power Generating Capacity: Justice, Microgrids and Utilizing the Common Pool of Renewable Energy.'' In Energy in Changing Climate, Social Equity and Low-Carbon Energy. New York: Zed Books.

Wüstenhagen, Rolf, Maarten Wolsink, and Mary Jean Bürer. 2007. ''Social Acceptance of Renewable Energy Innovation: An Introduction to the Concept.'' Energy Policy 35 (5): 2683–91. https://doi.org/10.1016/j.enpol.2006.12.001.